IN THIS ISSUE:

WHERE THE PETROLEUM GOES
WONDERS IN STEEL FORGING

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HUMAN SPIDERS AND THEIR WEB: PAINTING THE CABLES OF BROOKLYN BRIDGE

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For each section of the country the diagrams refer the output of other petroleum products to that of kerosene, showing how many gallons of the other liquid fractions are obtained for every gallon of kerosene recovered

How petroleum constitution and petroleum treatment vary from State to State

Where the Petroleum Goes

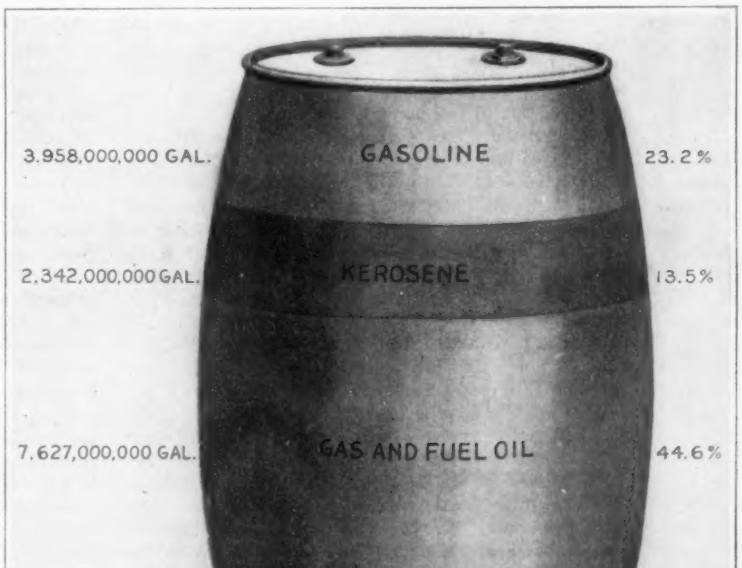
By J. Malcolm Bird

SOME weeks ago we discussed the gasoline situation from the viewpoint of sources of supply, showing as well as we could just where the petroleum comes from. But we pointed out in that article that gasoline is only one of the products of the petroleum refinery; it is therefore in order to ask and answer the further question "Where does the petroleum go?"

Individual refiners hesitate to answer this question. A given refinery deals with petroleum from a single section of the country, and employs a given process of extraction which is determined in part at least by the immediate market within easy shipping distance of the refinery. Thus one refinery may run heavily toward the recovery of one fraction, sacrificing others to this one; while another establishment may exactly reverse this choice. For it is to be emphasized that the refining of petroleum is not the sort of process that leads to a unique and inevitable result, like the sorting out of tall and short persons from a crowd. Within very wide limits, what we get out of our crude oil depends upon what we do to it; even more it depends upon the grade of the oil—another variable with very wide limits of its own. So when you ask the owner of one refinery or even of one large group of refineries to estimate what the United States makes out of its petroleum each year, he will throw up his hands and explain that the most he can do is to tell you what he makes out of *his* petroleum, and that he does not want to do that for fear that you will make the very mistake of supposing this to represent some sort of rough general average for the entire country.

The Bureau of Mines, however, presents figures which show the aggregate bulk of petroleum treated in the United States for each year, and the aggregate of each product recovered. These figures automatically represent American practise as a whole, and it is to them that we turn for the material for the present discussion. The first thing that they tell us is that the refiner was not "spoofing" us when he pleaded that his showing meant nothing for the country at large. For instance, the refineries of the east coast get only 11 per cent more gasoline than they do of kerosene out of their crudes. But for the Colorado and Wyoming refineries, the gasoline extraction exceeds that of kerosene by no less than 261 per cent. And the other sections into which the petroleum industry divides the country make showings that fall at various levels between these two extremes. So there is no joke at all about the statement that crude oils differ, and that the only way to see what a given oil will yield is to try it out.

For the United States as a whole, gasoline, fuel-oil and lubricating-oil production compare with kerosene output as here indicated



The bulk (left) of each major fraction; and the percentage (right) by volume which it constitutes of all petroleum treated

Where Uncle Sam's petroleum goes

The kerosene fraction is taken as the standard of comparison here and in the drawing that elaborates upon this aspect of the situation merely because it is the fraction most closely bound up with the history of the industry, and because at the same time it comes about as close to being present in constant proportion as any other constituent—though this approach to uniformity is by no means a narrow one. Referring the three other principal products to kerosene in this way, we see that for the entire country we extract 1.69 gallons of gasoline for each gallon of kerosene that the crude oil yields—the sectional showings, as we have just seen, varying from 1.11 gallons for the Atlantic Coast to 3.61 gallons for the Colorado-Wyoming field. For the fuel-oil and gas-oil group, the general performance is 3.26 gallons for each gallon of kerosene; Pennsylvania petroleum is the leanest in these fractions, yielding only .88 gallon for each gallon of kerosene, while California makes the prodigious showing of 11.28 gallons of the heavy oils to one of kerosene. American crudes as a whole yield .36 gallon of lubricating oil for each gallon of kerosene; the Colorado-Wyoming field with .05 gallon and the Pennsylvania refineries with .95 gallon representing the extremes. So it is quite obvious that we can make no generalization as to the per cent of gasoline, kerosene, etc., in petroleum; all we can say is that petroleum contains these constituents, in proportions that must be determined in each individual case.

If we cannot make any generalization with regard to the constitution of petroleum, however, we can safely assume that the grand total of the American output of crudes is substantially the same from one year to the next. Over a period of years this would not be a safe supposition, since one field gets worked out and new ones are opened up; but from one year to the next, the percentage of hydrocarbons that will distil over up to a given tempera-

(*Continued on page 20*)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Railroads the Foundation of National Prosperity

ASK the average man what is the material asset upon which the prosperity of the United States is founded and he will doubtless mention agriculture. Theoretically, he would be right. Modern civilization, however, particularly the mechanical side of it, has so greatly modified conditions that it may well be questioned whether in the United States, with its vast distances, the railroads do not take equal rank with agriculture as the foundation upon which our industrial and financial well-being is built up.

In the earliest times, as today, subsistence and wealth came out of the soil; but life in those days was very much a hand-to-mouth matter, and it was only as civilization developed that consumption of the fruits of the earth, whether in food or materials, took place at any distance from the source. This development has progressed to the point where the local consumption is absolutely insignificant, and practically the whole of the fruitage of the earth, whether in wheat, coal, oil, metals or what not, is carried to the four corners of the earth for consumption. Particularly is this true of the United States; and it is no exaggeration to say that our great railroad systems are not merely the foundation of our national prosperity, but are inextricably interwoven with the whole fabric of our daily life.

How closely the prosperity of the railroads is related to the prosperity of our great industries was forcibly brought home to the editor during a recent extended trip through the Middle West and the Northeastern states. In establishment after establishment we heard a story which ran somewhat as follows: "We are overloaded with orders. We have all the labor we require, and in the main it is contented and satisfactory. But our operations are limited by the scarcity of cars and the general let-down of transportation. We are able neither to obtain the necessary raw materials nor to ship the finished product." Evidence of the literal truth of these statements was to be seen in the general depletion of stockyards at one end of a works and in the congestion of finished products awaiting shipment at the other end.

So far as legislation is concerned, the most effective plan for the Government to follow in assisting to bring back normal conditions would be immediately to give every possible assistance to the railroads in making good the serious shortage of locomotives, cars and general equipment. Above all, effort should be made to build, with all possible speed the greatly needed freight cars. Until the shortage has been relieved, we may try every possible means to bring back normal conditions without avail. The cry for increased production is futile, since the railroads are not able to handle even the present output.

An analysis of the condition of our railroads, which we published in January, showed that under normal operation they require about 2,000,000 tons of steel rails per year, whereas in two years, the Railroad Administration had purchased directly only 200,000 tons of steel rails. Annually, the railways require about 100,000,000 new ties, but apparently, under Federal control there will be a shortage of about 25 per cent, or say 50,000,000 ties. During the four years prior to Federal control, the railways built an average of 100,000 freight cars per year, whereas the Administration had purchased only 100,000 freight cars in two years of which only 90 per cent had been delivered. Moreover, during the past two years, freight equipment had not been maintained in normal condition. It is estimated that about 200,000 new cars must be built in 1920 to make good the deficiency. The same story of shortage had to be told with regard to locomotives. The normal requirements are about 3,000 new locomotives per year. Yet during Federal control, only 2,000 locomotives, or one-third of the normal requirement have been provided.

It is one of the marked futilities of human nature that it is ever prone to give its attention to the things remote, and overlook those which are pressing for attention close at hand. Truly, a prophet is not without honor save in his own country—and amid the thousand and one nostrums that have been shouted at the dear people in the effort to get matters straightened out, we are hearing far too little about the one outstanding and supremely important question of the era—namely the rehabilitation of our great railroad systems.

The Scientific Value of Speed Contests

IN all great sporting contests in which high speed is the deciding factor, many people, in whom the critical faculty is developed at the expense of others equally valuable, make themselves audible in protest against the sacrifice of strength and durability which is necessary in producing a first-class racing machine, be it airplane, yacht or automobile. "What is the sense," they ask, "of building a contraption which, if it should be so fortunate as to hold together for one supreme effort, has no further use in the broad field of sport and pleasure?"

An off-hand answer to this question would be to remind these gentlemen that sport is sport; that the craving for high speed is a protest against the natural inertia of things; and that, if a man does not possess in his veins the good, red blood to which speed as an element of sport appeals, it is more his misfortune than his fault, and he is to be pitied rather than blamed. But, as a matter of fact, the ardent pursuit of speed in racing machines has reacted most favorably upon the mechanical arts. The race course is a very practical, man-sized kind of laboratory, where the products of the labor of the designer at his drafting board are given a gruelling test, during which the one weak link in the chain, if there be such, is certain to be disclosed. The great value of the construction and competition of racing machines is that we gain in knowledge of the dynamic as compared with the static stresses. Static stresses can be determined with great accuracy, and the testing machine gives us equal accuracy in determining the strength of materials; but in driving an automobile at a racing speed, and even more in smashing one's way with an oversparred and lightly-constructed yacht against short, snappy seas, there are dynamic stresses developed, the exact strength and effect of which no man can foretell through the medium of theoretical calculations.

Moreover, racing has greatly stimulated the quest for materials that are light in proportion to their weight; and there can be no doubt that for the many wonderful alloys which are available in the constructive arts today we are beholden, not a little, to the craze for speed, with its demand for a maximum of strength with a minimum of weight. To think of the racing car is to think of aluminum, vanadium steel, and last, the wonderful molybdenum steel; and a retrospective survey of the America's Cup races calls to mind the hollow steel boom of "Valkyrie III," the Tobin bronze and aluminum hull of "Defender," the light but strong hollow wooden spars culminating in the great hollow mast of "Shamrock IV," and the tapered, hollow aviation spar which forms the topmast of "Vanitie," to say nothing of the aluminum gaff carried by "Resolute." A test case as to the industrial value of yacht construction is the three-ply mahogany shell of "Shamrock's" hull, which proved so tough and strong and water-tight that its designer built Government ships, during the war, of a thousand tons capacity, on this principle.

And to get away from man-made machinery, who shall measure the enormous benefit conferred by the centuries of effort to produce the thorough-bred race horse of today? So valuable has been this effort of man to coöperate with nature, that the last word of praise which we can give to a horse is to speak of the thorough-bred strain that runs in its blood.

A Problem of Freight Distribution

IN a recent issue we referred to the proposed solution of the problem of freight distribution on Manhattan Island which contemplates the bridging or tunneling, or both, of the Hudson River for the purpose of bringing standard freight cars to the northern part of Manhattan Island and distributing them to warehouses and steamships by means of an elevated marginal railroad extending along the Hudson River waterfront. With such terminal facilities it would be possible for a freight car that was loaded at New Orleans, St. Louis, Chicago or San Francisco, to pass directly to a storage warehouse or a steamship on Manhattan without breaking bulk.

There is another scheme of distribution which involves a principle which has been receiving increasing recognition since the introduction of motor trucks, and which we believe is destined to be a powerful factor in solving the future problems of freight handling and distribution in such congested centers as Manhattan. We have in mind a plan which is sponsored by Colonel W. J. Wilgus, former Chief Engineer and Vice President of the New York Central Railroad Company, which contemplates the construction of a special system of small electrically-operated subways, similar to one already in existence and operating successfully at Chicago, for the delivery of freight directly to the basement floor of the consignee. Reference was made to this system in a paper read by Colonel Wilgus at a recent meeting of the New York section of the American Society of Civil Engineers, which is published in full in the July issue of the SCIENTIFIC AMERICAN MONTHLY. Colonel Wilgus disapproves of the plan for bringing the full-sized freight cars of the railroads onto Manhattan Island. He believes that inasmuch as somewhere in the metropolitan district there must be a transshipment of Manhattan freight from the standard railroad car to a distributing vehicle, it should not be done on costly property and among congested surroundings located as near as possible to Broadway. He believes it would be more economical and convenient to effect this distribution at the western road terminals on the New Jersey meadows, carrying the freight thus distributed to Manhattan by tunnel in trains of electrically-operated, small-unit vehicles. Distribution would be by way of small subways located near the surface, which would deliver these cars direct at, or into, the basements of the warehouses and manufacturing establishments of the consignees on Manhattan. Where delivery was not made direct by these electric freight trains, the containers holding the freight would be removed from the cars and placed on motor truck chassis for short radius "store-door" delivery. This principle of using standardized freight containers, which can be mechanically lifted from railway trucks and placed upon motor chassis, is already in successful operation in several localities, and there is no doubt that its extended application will prove to be highly economical in reducing labor costs.

The plan of bringing the full-sized railway freight cars by bridge or tunnel to a marginal railway on Manhattan is not antagonistic to the scheme of Colonel Wilgus for classifying freight in Jersey City for distribution by means of small electrically-operated freight subways. The one system would be complementary to the other, and there is room for both.

We have touched upon but one point only of this paper, which deals with the whole railway situation in its relation to the all-important question of pier accommodation. The author believes that every effort should be made to have the Dock Department enlarge the width and increase the rail and mechanical facilities of the 125-foot piers that are proposed at Staten Island. We commend the paper for careful reading, as being a complete summary of the transportation problem as affecting the interests of the leading seaport of this country.

Engineering

Hydro-Electric Possibilities in Transcaucasia.—The next few years will witness a great development in the utilization of potential water power for electrical purposes in Transcaucasia. The mountainous character of the country and the proved mineral wealth are the two important factors that will make these undertakings commercially profitable. The total existing hydro-electric stations yield only 6,725 horse-power, although surveys have indicated that over 350,000 horse-power is possible.

American Locomotives for Portuguese East Africa.—The Lourenco Marques Railway has recently received eight American locomotives, five of the Santa Fe type and three of the Pacific type, and they have proved far superior to any of the foreign engines in use, according to a U. S. Consular report. The Lourenco Marques Railway connects the port of Lourenco Marques with the railway system of South Africa and is the most convenient route for imports into the region of which Johannesburg is the center.

Rail-Creep on Railroad Bridges.—The chief engineer of the Madras Railway has something to say regarding rail-creep on railway bridges in India, in a recent issue of *Indian Engineering*. In the case of the Godaveri bridge, where the creep amounted to as much as three to four feet a year, a special cast-iron sleeper was designed to suit the 75-pound flat-footed rail, with a jaw large enough to receive a lock-fast steel key. This reduced the creep to insignificance, and generally the author is confirmed in the conclusion reached by him in 1887 that "creep" can only be remedied by effective anchorage.

Lumber Conservation.—At last we Americans are thoroughly aroused over the seriousness of our lumber resources. For decades we have been cutting down our splendid forests with little thought of reforestation; for the past ten years a mighty host of periodicals and newspapers have been clamoring for thousands upon thousands of tons of paper each week, which has meant the cutting down of thousands of acres of splendid timber. With the advent of the great war, more forests were cut down to build the expansive cantonments, wooden ships, and other things. And now we are confronted with seriously depleted forests. Reformation and conservation are the subjects of the hour, for wood is something without which we can hardly get along. Other countries, not favored with the abundant forests which we have had in the recent past, have long exercised good judgment and care and reforestation in guarding their timber reserves. France, for instance, practises the greatest economy in the use of lumber. Most French farmers get along with the identical buildings of their great grandfathers. The annual consumption in France is not more than one hundred board-feet per capita, or less than one-third the quantity used by Americans.

Consistency of Concrete.—In an article appearing in a recent issue of the *Canadian Engineer*, H. E. Davis has much to say about concrete road construction. Among other things he deals with a simple method of checking the consistency or flowability of concrete so as to keep the water content of the mixture fairly constant. The question of correct consistency is, in most instances, treated with the proportioning of aggregates, as this combination results in the best concrete. Most engineers prefer dealing with the question of consistency first and allowing the question of proportion to be dealt with afterwards. A scheme that was used on certain work proved to be of great value in keeping the consistency constant. The method was to place a shovelful of green concrete at one end of an inclined board and note whether it would flow when the board was at the angle at which concrete of the best consistency should flow as predetermined by laboratory investigation. After heavy rains, stock piles absorb a considerable quantity of water, but with the scheme mentioned above it is quite easy to keep the same consistency throughout the work. It requires very little time to determine the right angle and the method has the advantage of keeping the water content of the mixture fairly constant and assists in placing and finishing.

Science

Endowment of the National Research Council.—It is announced that the Carnegie Corporation of New York will place a fund of $5,000,000 in the hands of the National Academy of Sciences to be used as a permanent endowment of the National Research Council and to provide a building in Washington which will house both the Council and the Academy.

A Scientific Conference on the Pacific.—The Committee on Pacific Exploration of the National Research Council is planning the program of a scientic conference to be held at Honolulu next August, under the auspices of the Pan-Pacific Union, at which it is proposed to outline some of the fundamental scientific problems of the Pacific Ocean region and to formulate methods for their solution.

Professor Pier Andrea Saccardo, who recently died, was born at Treviso, Italy, in 1845, and during the greater part of his professional life was director of the Royal Botanic Garden of Padua. Saccardo's name is a household word among botanists all over the world, chiefly on account of his great work on the fungi, the Sylloge Fungorum, which has been in course of publication since 1882, the twenty-second volume having been published in 1913. Prof. Saccardo was, however, the author of much other important literature relating to mycology and other branches of botany.

The Amundsen Expedition.—According to *La Géographie*, the Norwegian Government has sent out a supporting expedition for Roald Amundsen's transpolar voyage. This supporting party, which is led by Lieut. G. Hansen, of the Danish Navy, who was with Amundsen in the voyage of the "Gjoa" in 1903-5, spent the past winter at Etah, in northern Greenland, and expected to leave in March with a dozen sledges for Cape Columbia. Amundsen planned to leave his ship, the "Maud," at the most northerly point attained in its drift, and travel over the ice to Cape Columbia, where he is likely to arrive in March of next year.

Scientific Workers and the Income Tax.—In Great Britain, where the income tax is an even more serious burden upon inadequately paid scientific workers than in this country, a committee representing the British Association of Chemists, the Institute of Chemistry, and the National Union of Scientific Workers is circulating a petition which will be presented to the Treasury, in favor of deducting various expenses incurred in scientific work from the amount of income on which the tax is computed. These expenses include subscriptions to scientific and technical societies and periodicals, purchase and renewal of apparatus and materials used in scientific work, rent and expenses of laboratories, etc., expenses incurred in attending scientific meetings, provision of special clothing for work and renewal of clothes damaged in the course of employment, and various other analogous professional expenses.

Effects of a Reservoir on Rainfall.—The U. S. Weather Bureau was recently asked by a foreign government for an opinion as to whether it would be worth while to construct a large reservoir for the purpose of increasing the rainfall in a subtropical arid region. Although such questions have often been considered before, the Bureau in this case made a study of the meteorological records of regions of the United States adjacent to large inland bodies of water. The cases considered were the creation of the Salton Sea, in California; the building of dams and the reservoirs formed thereby in Minnesota; and, finally, the probable influence of the Great Lakes on the precipitation of the Lake region. The rainfall records of Arizona show more rain, on an average, since the Salton Sea was formed, in 1906, than before, with the exception of the dry year 1910. The data are not, however, strictly homogeneous, on account of the increase in the number of reporting stations. Furthermore, the proximity of the Gulf of California, a body of water vastly larger than the Salton Sea, seems to vitiate the argument that the presence of Salton Sea has materially affected the rainfall of the region. In the case of Minnesota, the yearly averages for a period of 32 years do not show any progressive increase in the rainfall of the state. A consideration of the probable effect of the Great Lakes led to the conclusion that 2 or 3 inches of the annual rainfall might reasonably be ascribed to the moisture supplied by the Lakes.

Astronomy

Another Nova in the Andromeda Nebula.—The seventeenth nova found in the Andromeda nebula is reported by Milton Humason in the *Publications* of the Astronomical Society of the Pacific, No. 185. It appears on plates taken at Mount Wilson last October, but is invisible in earlier and later plates. It is nearer the center of the nebula than any nova found in that area since the discovery of No. 1 in 1885 and its recorded maximum brightness exceeds all but No. 1.

Solar Activity in 1919.—According to a summary of this subject published in the *Monthly Notices*, R.A.S., it is now evident that the maximum of sunspot activity was reached in 1917. The lower average latitude of spots during 1919 and the decrease, both in the mean daily spotted area and in the size of individual groups, is strong evidence that the maximum has been passed. The year 1919 was, however, a period of great solar activity. The month of greatest spotted area was June, though on some days during March, May and August the maximum area of about 2,500 millionths was reached.

Another Nova in Sagittarius.—The systematic search that is being made for new stars on the Harvard photographic plates has yielded numerous discoveries, of which one announced March 10, 1920, is typical. A Harvard College Observatory bulletin says: "A new star, making the sixth in constellation Sagittarius, has been found by Miss Woods. The nova is not seen on a plate taken on July 24, 1905, which shows stars of about the twelfth magnitude, but appears on a plate taken on July 26, 1905, of mag. 8.8, and on July 27, of mag. 7.1. It is seen on ten plates taken in August of that year, but decreased rapidly in brightness until August 22, when it was mag. 10.0. It is not visible on recent plates. No spectrum of the star was obtained."

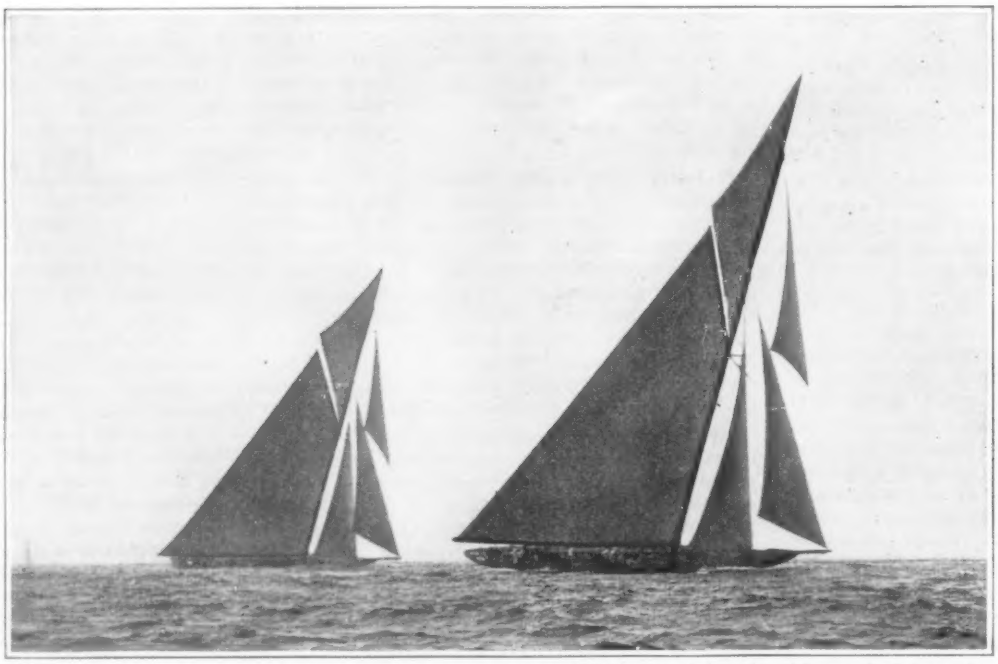
Some Facts about Satellites.—From an interesting summary of knowledge concerning the satellites of the solar system, by Dr. S. B. Nicholson, we glean several facts which are perhaps unfamiliar to many students of astronomy. The writer points out, for example, that, on account of our nearness to the sun, the moon is by far the brightest satellite, as seen from the surface of its primary. Jupiter's satellites are large (two of them are larger than Mercury) and some of them are quite near the planet, but their total light on Jupiter, even if all were in full phase at once, would be only one-third that of full moonlight on the earth. The outer satellites of Jupiter are so far from their primary that the perturbative action of the sun is very large; in fact, it may be shown that if it were not for their retrograde motions, Jupiter VIII and IX could not be permanently held by the planet. Perturbations change their orbits so much that it is almost impossible to think of them as orbits, in the ordinary sense. For instance, the eccentricity of Jupiter VIII had been known to change from 0.50 to 0.23 during two revolutions of the satellite. It is quite possible that Saturn and Jupiter have undiscovered remote satellites fainter than the 16th magnitude.

New Method of Measuring Double Stars.—Experiments have recently been made by Messrs. Pease and Anderson, of the Mt. Wilson observatory, in the application of Michelson's interferometer method to the measurement of close double stars. An apparatus was constructed with movable slits about 4.5 mm. wide and 25 mm. long, and this was installed about 117 cm. inside the Cassegrain focus of the 100-inch telescope. The diameter of the cone of light at this point being about 73 mm., the arrangement was such that the slits could be separated by this amount. The apparatus carrying the slits could be rotated about the optical axis of the telescope, for determination of position angle. The fringes of stars were observed through an eyepiece of 1 cm. equivalent focus. Much higher magnification is, however, desirable. The investigators report that the resolving power of the telescope for double stars is at least doubled by this method; that good "seeing" does not appear to be important, as the fringes were very sharp under poor atmospheric conditions; that very small angular separations can be measured with an accuracy at least as great as that for larger angles; and that the position angle can be determined as accurately for very close doubles as for those widely separated.

Tuning Up for the Cup Races

"Shamrock IV"—The Unknown Quantity Among Four 75-Foot Racing Yachts

By J. Bernard Walker

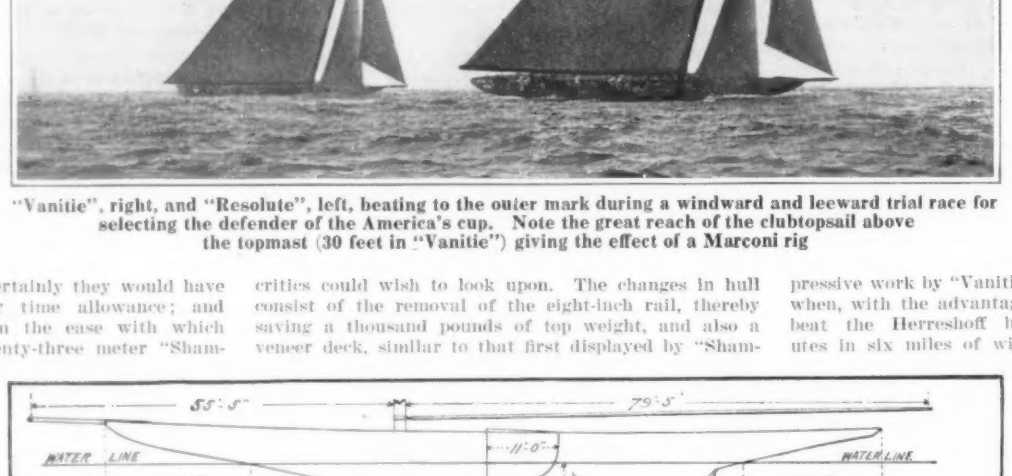


"Vanitie", right, and "Resolute", left, beating to the outer mark during a windward and leeward trial race for selecting the defender of the America's cup. Note the great reach of the clubtopsail above the topmast (30 feet in "Vanitie") giving the effect of a Marconi rig

WHEN Sir Thomas Lipton made the very sensible suggestion that in view of the great cost of the modern 90-foot racing yacht, the cup contests for 1914 should be sailed with yachts of 75-foot waterline length, he introduced an uncertainty as to the comparative speed of the 1920 challenger and defenders, which has added a strong spice of interest to the contests. For it is nearly two decades since we had a 75-foot class, and therefore we have nothing on this side of the water that has tried conclusions with the British twenty-three meter (75.4 feet) yachts, which were raced so hard and continuously in European waters in the years preceding the war.

We have good reason to believe, however, that both the defending and the challenging boats are phenomenally fast. "Vanitie" and "Resolute," thanks to their narrow and lofty rig and the refinement of their hulls, are nearly as fast, boat for boat and under equal conditions, as the old 90-footers—certainly they would have no difficulty in saving their time allowance; and "Shamrock IV," judging from the ease with which she pulls away from the twenty-three meter "Shamrock," is undoubtedly herself a very fast boat. But of that, more anon.

This element of uncertainty is answerable, in great part, for the fascination of yacht racing, and it is in full force in the 1920 series for the American Cup. Take, for instance, the battle royal which has been going on between "Vanitie" and "Resolute." "Billy" Gardner (as his host of friends know him) had shown down through the years that he was no mean antagonist for the redoubtable Herreshoff; and when Mr. Cochrane gave him an order for the 75-foot "Vanitie," there was great interest to see what he could do in producing a large out-and-out racing craft of America's Cup type. In the trial races of 1914, "Resolute" established an undoubted superiority, which was repeated and, indeed, emphasized in the trials of 1915. It was believed, however, that "Vanitie" suffered from indifferent handling, and that changes in her sail plan would serve to develop the speed that lies in her well-turned hull. So this year her mast was lengthened two feet, and changes were made in the direction of giving her sail plan greater height in proportion to its base. She was furnished with an entirely new set of Ratsey sails, and she now carries as perfect a suit as the most captious critics could wish to look upon. The changes in hull consist of the removal of the eight-inch rail, thereby saving a thousand pounds of top weight, and also a veneer deck, similar to that first displayed by "Shamrock" in 1914, was substituted for her pine deck, with the result that another 2,000 pounds was eliminated. Altogether, alow and aloft, some 3,500 pounds of weight has been saved, and this was placed, as inside ballast, low down in the hollow keel. The result of these changes, coupled with the excellent handling which she is now receiving from Rear-Commodore Nichols of the New York Yacht Club, has been magical. Of the eight races which have been sailed at the time of writing, five have been won by "Resolute." But of these one should be ruled out because it was a mere drifting match, and in another "Vanitie" was beating "Resolute" badly to windward, when her centerboard fouled a lobster pot, and she dragged several fathoms of line and part of the gear with her, thus slowing the boat down considerably. Of the other six races, three have been won by "Vanitie" and three by "Resolute." It is considered by the committee that the most impressive work by "Vanitie" was done in the eighth race, when, with the advantage of a twelve-knot breeze, she beat the Herreshoff boat handily some two minutes in six miles of windward work.



Midship section and outboard profile of the 23-metre "Shamrock," shown in comparison with "Shamrock IV" and the two cup defenders "Resolute" and "Vanitie"

Thus far, the "Vanitie" seems to be master of "Resolute" in winds of from twelve knots upward. In the lighter winds, particularly in drifting matches, "Resolute" seems to have the edge on the Gardner boat. Evidently the Race Committee will have its work cut out in selecting the defender. "Resolute" has the advantage that the challenger will have to allow her one minute and thirty seconds more than she would have to allow "Vanitie"; on the other hand, "Vanitie," both in hull and rigging, seems to be the more robust and reliable craft—a matter which must needs carry considerable weight with the committee in determining which boat to send out to the Sandy Hook course to meet the redoubtable "Shamrock IV."

We know that whichever craft is chosen, the Cup will be defended by an exceedingly fast boat, and the question naturally arises—how fast is "Shamrock IV"? Apparently she will spread from 1,200 to 1,600 square feet of canvas more than her competitor, and, judging from her performance in these waters, she seems well able to carry her lofty rig. The only means of getting a line upon her speed is by comparison with the twenty-three-meter "Shamrock," and in this connection, it is interesting to study her midship section and profile

as shown in the accompanying comparison of the four 75-footers.

The twenty-three-meter boat was built under the International Rule, which was drawn up with a view to getting away from the extremely light construction of the racing yachts of the earlier years of the present century, and producing a vessel combining "habitability with speed." The rating of the yachts under the International Rule is determined by adding the water line length to the breadth; plus half the girth measured at 0.55 from the bow end of the water line; plus a factor, d, which is the difference between the chain girth and the skin girth at the same point, plus one-third the square root of the sail area minus the freeboard. The water line length, it should be noted, is modified by a consideration of the girth at the bow and the stern ends of the water line.

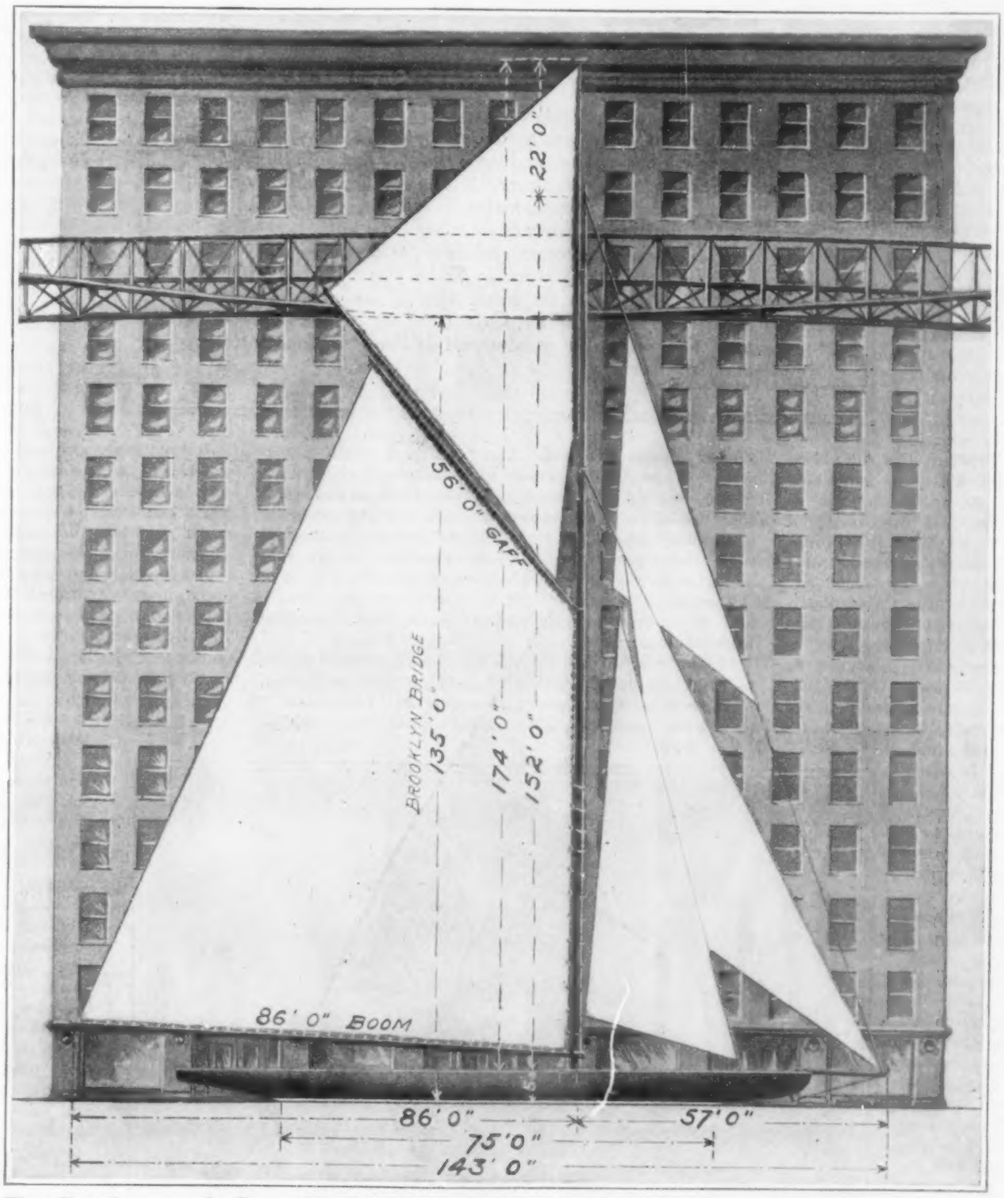
The object of this rule, as in the case of the American rule under which the present races are being sailed, was to produce a deep-bodied boat with fairly sharp and easy ends. But the International Rule goes farther than we do, by prescribing the strength of the scantling and requiring that all yachts must be built under the survey of one of the three classification societies, Lloyds, the German Lloyds, or the Bureau Veritas. Under this rule, the boats have to carry solid masts and must be fitted with complete cruising accommodations. All of the leading countries, with the solitary exception of the United States, adopted this rule, and many fine yachts were built under its restrictions. Among these was the 23-meter "Shamrock," which took the water in 1912 and proved to be the fastest vessel of her class. She was built by Fife, and, like all of his boats, is an exceedingly handsome craft.

The all-important question just now is—how fast is the older "Shamrock"? It will be seen from the accompanying diagram that she is nine tons heavier in displacement than "Shamrock IV" and nine and one one-half tons heavier than "Resolute." The extra weight is easily accounted for by the fact that she has a solid mast weighing two and one-half tons, that she has sixty-eight tons of lead ballast, and that she is a thoroughly equipped cruiser below deck, with staterooms, galley, accommodations for the crew, and every convenience required for comfortable cruising. She has a sweetly turned hull, which should be easy to drive. Like all of the International Rule boats, she carries a large sail spread, the topmast truck being 140 feet above deck. The length from tip of bowsprit to end of boom is 144 feet, which is a foot more than the same measurement on "Shamrock IV" and twelve feet more than on "Resolute."

As to the speed of the twenty-three-meter craft, we know that she swept the boards in British waters in 1912, and the records show that in winning the Queen's Cup off the Isle of Wight, she sailed the forty-eight-mile course in exactly four hours at an average speed of twelve knots. This, however, may not have been as good as it seems, for the reasons, first, that the course is laid in the sheltered waters to the north of the Isle of Wight, and secondly, that the tidal currents are very swift, and it is quite possible for a yacht to have a four-knot current in her favor on certain legs of the course. A more reliable measure of her speed was obtained by Captain Diaper, who brought her across the Atlantic. He tells us that her best sailing, as measured by patent log was 11.7 knots for two consecutive hours. This was done under her greatly reduced ketch rig and in a heavy reaching wind and following sea.

Now "Shamrock IV" is a faster boat than the older craft to windward, as was shown in the first trial race off Sandy Hook, when she pulled out a lead of eight minutes and fifty-eight seconds in a beat to windward of ten and one-half miles. This she duplicated in the second trial race, when she gained 9 minutes in 10 miles of windward work. In reaching she does not do nearly so well, since in the same race she beat the older boat only fifty-one seconds in a close reach of eight and one-quarter miles. Down the wind with spinnaker, she pulls away from the older boat, but not in any such fashion as when they have sheets aboard in a thresh to windward. The yachting "sharps" of the daily press seem to think "Shamrock IV" is oversparred. On the other hand, designer Nicholson, after her first trials, removed several tons of lead because she was too stiff in light airs.

All things considered, there is reason to believe that this will be the closest contest for the Cup ever seen on the famous Sandy Hook course. As in the case of "Shamrock II," which was the best boat hitherto sent over for the Cup, the issue of the race will depend very largely upon the handling of the competing craft. Both the British and the American skippers, for the first time in these Cup races, will be amateurs, and each is recognized as being the ablest representative of the Corinthian sailor in the respective countries.



The tallest rig among the Cup yachts of 1920 is that of "Shamrock IV." With her water line at street level, the head of her clubtopsail would be level with the cornice of a 14-story office building. To make another comparison, it would extend 45 feet above the underside of the Brooklyn Bridge

Gas Laboratory of the U. S. Bureau of Mines

AMONG the many activities carried on by the United States Bureau of Mines is the work being done on gas masks for the protection of workers in various industries. So important is this work that the Bureau at its Pittsburgh station maintains a laboratory for the investigation of gases and the dissemination of information throughout the various industries concerned. The staff of this laboratory is constantly in receipt of problems relating to the protection of workers who may be exposed to gases, and valuable, practical results have been obtained as the result of research. Before the war the Bureau maintained crews trained in the use of self-contained oxygen breathing apparatus with enough oxygen compressed into metal bottles to maintain a man for half an hour. By the use of these the wearer could penetrate mines filled with deadly gases to rescue entombed miners. The experience of these men was of great assistance to the Government in developing the army type of gas mask. These masks differ from the oxygen breathing apparatus in that the masks serve only as filters for removing comparatively small amounts of noxious gases from the air.

The Bureau of Mines is now interested in adapting the gas mask to serve in the industries, where they are finding wide application.

The SCIENTIFIC AMERICAN in its issue of October 25, 1919, published an article on the gas mask in industry, which told of the numerous uses made of the mask, and in the current issue of the SCIENTIFIC AMERICAN MONTHLY for July will be found an article specially written for the SCIENTIFIC AMERICAN by S. H. Katz, Assistant Physical Chemist, Bureau of Mines, which will well repay a careful reading.

As an instance of the effectiveness of gas masks in industry, there is instanced the case of certain painters who were using an air-spray brush in painting some rather deep and narrow wooden bins. As a result of inhaling the turpentine, paint vapors, et cetera, the painters became sick and one man was for several weeks under the care of a physician. As a remedy gas masks were provided and the men worked on the job for months with no further ill effects. The Bureau is doing excellent work in testing the permeability of the material of which gas masks are made, and a schedule of tests and requirements necessary to secure the Bureau's approval has been established.

As showing the great care necessary in selecting gas mask material, Professor Katz quotes the case of the death of James S. Cunningham, foreman miner of the Bureau of Mines, who went down into a storage tank which contained seven inches of gasoline at the bottom, the air therein being charged with gasoline vapors.

He wore a half-hour oxygen breathing apparatus, but it was soon noticed that he was in distress, and in attempting to ascend the ladder he fell back into the liquid gasoline. In the subsequent investigation of the permeability to gasoline vapors of the rubberized fabric of the breathing bag, made at the industrial laboratory, it was found that the fabric was exceedingly permeable to gasoline vapors. Consequently further experiments are in process from the results of which specifications for breathing bags impermeable to gasoline and other vapors will be drawn.

The Romance of Invention—XIV

Cottrell—Catalyser

By C. H. Claudy

THE reader of this series might be pardoned if he had got the idea that all inventors fall under one of two types—the inventor of fiction, who gets swindled and starved, and the inventor of fact, who gets rich and famous. But Dr. Cottrell's case shows that there is at least one example of a third type—and surely this example makes the best story of them all. There is something that intrigues the fancy in the tale of the scientist who hits on an epoch-making discovery, who commercializes it for a return of millions of dollars—and who, after making provision for his own modest wants, devotes the balance of his royalties to the advancement of human welfare through endowed research. The story of Dr. Cottrell and his Research Corporation is really one of those things that go to support the thesis that truth is stranger than fiction.—THE EDITOR.

HUGGING his hard won secret to his bosom, the wild-eyed inventor, hounded by heartless capitalists, crawls to a corner of his miserable garret to die. 'Never shall they rob me of the fruits of my genius,' he breathes desperately. "They would exploit my brains for their own profit, but I will have it all, all, or no one shall have it.'"

Thus the inventor of the novel and the moving picture.

But not always thus the inventor of real life. Undoubtedly many who have been better scientists than business men have failed to realize the financial rewards their discoveries made for others; but, strange as it sounds in this dollar-chasing age, not all inventors want to make their inventions a source of personal profit.

There is Cottrell for instance—Cottrell who invented or discovered (it was a little of both) one of the fundamental processes for which patents have been granted, that of the electrical separation of solid and liquid particles from chimney smoke. "Electrical precipitation of suspended particles" is its proper name, and a very wonderful, if very simple, process it is, of which more in a moment. It is not only wonderful and simple but commercially it is extremely valuable, a process applicable to a great many different industries, and which, when used, in some cases adds the value of a by-product larger than the profits earned by the main product.

Here was a great chance for a man to get rich from the work of his brains. Cottrell, however, according to those who work with him and know him best, has so great a fund of optimism, and so large a love in his heart for science, for discovery and for making the products of both of service to humanity, that he preferred to devote his talents to better ends than the mere making of money.

So there was no attempt to exploit the Cottrell patents financially. Instead, he offered them to the world, to be used for the benefit of the world.

He did not make them public property, however, or do anything so inadequate as "give them to the government." Dr. Cottrell has pronounced ideas on the subject of making patents available to the general public and holds, and not without much reason, that to give them away is often to bury them, since what is free as air to all is frequently not thought of worth to any. Moreover, manufacturers hesitate to put money and time and plant into the production of an article which anyone can duplicate and anyone can sell. Finally, Dr. Cottrell doesn't believe that industry needs free gifts to keep it alive.

So he first offered his patents to the Smithsonian Institution to be administered by that body, and later, for administrative reasons, and with the cordial consent of the Smithsonian Institution, formed the Research Corporation of New York, and handed his patents over to its use. The Research Corporation is unique among institutions because its charter provides that no dividends shall be paid upon its stock and that the entire net profits are to be used for the advancement of technical and scientific information. In other words, while the Research Corporation is in business to make a modest amount of money, that money is not to be the personal profit of anyone, but is to be devoted to the advancement of science and industry. This, in brief, was Cottrell's idea of what ought to be done with his fundamental patents—that they ought to be made to work for the world, and the profits they made should also be made to minister to the world by being used to aid further discovery and invention.

Whether Dr. Cottrell will be longest remembered for his contribution to applied science, or for his formation of the Research Corporation and any gifts which it may give to the world through its investigations and through the labors of those who win its Fellowships, is not a question which can here be debated.

But as the Cottrell patents were, in a sense the "working capital" of the corporation (its actual capital paid in at its foundation was $10,000 and its total capitalization as provided for in the charter, double that amount) it may here be of interest to say a word or two as to what these patents are and what the Cottrell process is, for the benefit of those whose knowledge does not extend to an understanding of one of the most beautiful applications of pure science to the industrial arts.

In many industries a useless by-product is gas of one form or another, which gas carries in it a large quantity of suspended matter. Prior to the Cottrell process, these suspended articles were carried off with the gas or smoke and lost. Many of them could not be screened out as any screen fine enough to catch them would clog up and choke, and the draft would cease. They could not be removed by such familiar processes as passing the gas through a liquid to dissolve them, in some cases because the solids were not easily soluble, in others because of the expense of such a process.

Then came Cottrell with his electrical precipitation and waste-product problems of a hundred industries were solved.

If you were to go into a well equipped laboratory and point a needle charged with a high voltage current towards a plate charged with a current of the opposite sign, you would get, at a certain distance, a distinct wind or air current—sufficient, in the familiar laboratory experiment, to blow out a candle flame. The air impulse is caused by the electrical charging of the molecules of the air so that they are repelled by the one and attracted by the other electrode. Such is the Cottrell process, which can remove from gas the solid or liquid globules which it may contain. Just as the molecules of air do not stick to the plate electrode, so will the molecules of any gas through which the current is sent, not stick to the electrode; the process removes solid or liquid matter from gas, not gas from gas. But, by a regulation of the temperature of the gas to which the current is applied, one or more processes of removal can be carried out. Solid matter can be eradicated at a certain temperature. When this is lowered it produces a liquid content to the gas, when the liquid globules can be removed. The Cottrell process, then, is not only a precipitation but a selection of what is precipitated. In practice the process operates by passing the gas or gases, containing the finely divided solid or liquid particles which are to be removed between two systems of electrodes, one of which is charged so that there is maintained a difference of potential of from 15,000 to 100,000 volts between the electrodes. This difference of electrical potential varies according to the spacing between the electrodes. The small particles of matter becoming electrified in the intense electrical field are precipitated on the electrodes, the result being that the gas comes out practically clear of solid matter, which is all retained in the apparatus, from which it is later mechanically removed.

In smelting and refining furnaces much copper, lead, silver, gold, zinc and other valuable metals is wasted in the smoke and gas from the furnaces. Applying the Cottrell process saves all such waste, to an amount which not only pays for the installation and operation of the apparatus but in many cases delivers a handsome profit besides. In other industries where the fumes given off are noxious, the Cottrell process not only recovers an otherwise wasted dividend but deprives the gases of their noxious elements. Sulfuric, nitric and hydrochloric acids are thus recovered; arsenic, lead, zinc and other poisonous material are removed and in one case at least, that of obtaining potash from cement-laden air in cement works, the recovered material competes with the main product in value.

In practice, the negative electrodes are small, such as wires or chains, and the positive electrodes are large, such as plates or pipes. The electrodes get their current usually through some high voltage transformer and rectifier, in order to obtain from ten to one hundred thousand volts of direct current. The expense of operation of the precipitating plant is but little more than the current expense plus the removal of the precipitated material.

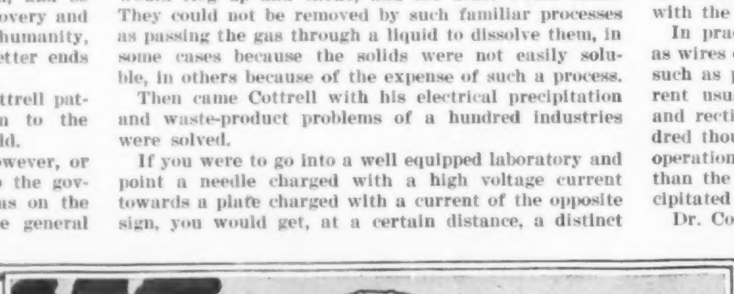
Dr. Cottrell would be the last man in the world to claim all the credit for having set before a waiting world a successful system for removing solid or liquid particles from gas. Many inventors have worked on the same problem and many have been the investigations leading towards the ultimate truth. But none can deny to the Cottrell patents the honor which comes to any which pass the final test of working. There were telephones before Bell, flying machines before Wright, phonographs before Edison, cables before Field, and wireless before Marconi, but they were the men who "did it"; who brought the knowledge which was previously in an abstract and theoretical form, into concrete practice.

So with Cottrell; his patents *worked*, and his brains put electrical precipitation into industrial practise.

Prior to his advent into the public eye he was an instructor in Physical Chemistry at the University of California. He holds a B. S. from that institution, is Doctor of Philosophy from Leipsic University—if he writes his name and titles in full he is Frederick Gardner Cottrell, B.S., A.M., Ph.D. Later he became assistant professor at the university, but then the Bureau of Mines reached out a long arm and grabbed him, and he came—for a little while. He has been with the Bureau of Mines now since 1913, first as Consulting Chemist, then Chief of Physical Chemistry, next Chief Chemist, and is now Chief Metallurgist.

Recently he received the thirteenth Perkins Medal for his achievements, the presentation being made before the New York section of the Society of Chemical Industry. In a speech made about him at that presentation it was said: "It was a familiar phrase at the

(Continued on page 22)



Frederick G. Cottrell, inventor of electric precipitation

What Industry Can Do for Americanization

And Some of the Things Which the Industries May Expect from Americanization in Return

By H. T. Waller

INDUSTRY occupies a strategic position relative to the foreign-born. Industry has needed the man with the pick and shovel, the man with brawn, the man eager to make good, the man willing to work under all conditions and at all times. The industrial progress of this nation has its foundation built by the supply of immigrant labor. Industry, however, during the later years has come to recognize a much greater potential force in its unskilled labor than heretofore. It has come to recognize a terrific loss due to misunderstanding; it has realized also that only as understanding is created between employee and employer can best results be secured.

Outside of industry certain social and educational forces have been working many years to create a better understanding of the foreign-born situation. Many have recognized that only as a common language was used could the best of understanding be created and maintained, and to this end educational and social workers have been seeking to develop an Americanization consciousness that would appreciate the potential value of the immigrant. As the work progressed under private and organization leadership it soon developed that in order effectively to carry on Americanization work, in order to reach positively the great army of workers, it was necessary to have classes and activities conducted where these people were brought together in natural groups. This place is the industrial plant. Watch the thousands of employees as they come to and leave work. They come from and scatter to all points of the compass. While in the plant and even in the departments of the plant are gathered large groups of these men who here, at least, have a common point of interest. It is the place where their daily bread is earned, and where they are earning that which will enable them to safeguard and enjoy the future. It has been found also that of all influences that are effective in dealing with the foreign laborer the influence of his foreman leads. Consequently, certain workers in this field have endeavored to develop a plan by which the largest number of foreign employees might be most effectively reached for the benefit of industry, for the benefit of themselves, and for the benefit of the community. For, after all, the interests of the one are the interests of all three, and injure the best interests of one and you will injure the best interests of all three. *For the basic interests of employer, employee, and community are identical.* What then can industry, occupying as it does the strategic vantage point, do?

Industry can and should supply within its organization a person or persons charged with definite responsibility for developing the best interests of the foreign-speaking employees in the plant. No outside agency can come in and do what this agency from within can do. It is necessary that industry shall stick to its job of production and any work that is done must be so conducted as not to interfere with production, but this has a vital influence upon production, therefore, find a man or men with high purpose, social vision, and practical common sense, who will work together with the foreman, assistant foreman, and American workers of industry. The result will be an established point of contact with the foreigner that is bound to be of tremendous value. The men responsible for Americanization in the industry must be men of community vision, not men who are simply creating a department and a job for themselves. This latter point of view would be suicidal to attainment of the object desired.

For when it comes to the question of instruction of employees in the knowledge of English, the ideal is the educational leadership of the community, namely, the Board of Education; and the point of coupling the public educational forces to the industrial power is a delicate one and calls for splendid leadership on both sides. Industry can do more for the promotion of Americanization than any other single agency. In fact, industry must do more, for it is to the best interests of industry that it should be done. The type of community in which a man lives determines more than we now realize the type of production that he turns out. There is, therefore, a compelling economic force which determines industry's place in this great problem.

Today we are facing the problem of a great labor shortage due to natural causes. The fact that foreign labor is returning to Europe is a natural thing, but if industry and the community had paid special attention to establishing a sympathetic intelligent point of contact with foreign labor, the result would have been the establishing of permanent homes in this country on the part of the foreign laborer, to a very much greater degree than has been the case. Only in so far as we are able to establish this personal contact are we going to be able to stabilize labor. Industry must, therefore, take a position of leadership in the problem of Americanization, and where community educational forces do not recognize their responsibility for adult education, then industry must and can take the leadership, and furthermore must see to it that there is a change in attitude on the part of the educational leadership in such a way as to meet the needs of the community which they are serving. One emphatic warning is essential in connection with this problem. Force, compulsion, paternalism should be shunned as though they were a plague. We do not want American citizens as a result of compulsion. Friendship is not a thing that can be forced. Friendship is the result of sympathetic understanding. Friendship will result in the building of an ideal community. Understanding will result in the creation of an ideal industrial relationship. It is possible to secure this through the point of contact established in industry through the agency of Americanization leaders.

In the coöperation of industry and the Board of Education there is a combination of industry and community that is bound to react most favorably upon the individual, the industry, and the community.

Industry holds the vantage point of economic leadership. The solving of this great national problem will depend very largely upon the vision of industrial leaders who recognize the tremendous value of an intelligent understanding.

Industry must then supply leadership, money, and coöperation in the work of Americanization. The leaders of Americanization also must take their position with the leaders of direct production, working with them in close coöperation in order that there may be developed an industrial life based upon sympathetic understanding and mutual helpfulness.—*Address before the National Safety Council.*

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Home-Made Refrigeration

To the Editor of the SCIENTIFIC AMERICAN:

May I have leave to remark the article in your May 15th inst. issue entitled "To Offset the High Cost of Ice," by W. Lambert, and say:

The method explained and illustrated is not new in the field of ice manufacture and mechanical refrigeration and if "the system has been perfected" I would be surprised but also pleased to be convinced of it.

"Perfected" is a strong term.

I take it to mean that the device has been made safe to operate and that it would be operated with commercial profit.

In close observation over thirty years in the fields of ice-making and refrigeration, I hardly think I exaggerate in saying I have known of nearly a hundred concerns that have undertaken the manufacture, sale and installation of machines of this type, none of which survived on account of financial failure.

Further, a number of such machines have exploded, causing loss of several lives and serious destruction of property because someone failed to open a valve that should have been opened before getting up pressure.

Installation of such refrigerating plants should be prohibited unless fitted with safety devices that would render them dependably proof against explosion regardless of the dependability of anyone who might be responsible for their safe operation.

It sounds plausible and has been luring bait for financial "suckers" heretofore, but would-be capital stock investors and contemplating purchasers of such plants would well be warned to heed the record of experience before parting with their good money.

A. C. JACKSON.

St. Louis, Mo.

Accidents That Happen and Others That Don't

To the Editor of the SCIENTIFIC AMERICAN:

I have been much interested in noting the fact that you are occasionally publishing articles having to do with industrial relations and accident prevention. The article in the April 10th issue, "How Much Is a Worker Worth?" is particularly interesting, but there are a few points in this article that from the standpoint of practical accident prevention I believe should be cleared up.

Excellent as the article is, in these cases it reads either as though the author accepted some hearsay evidence without investigation, or else made his statements without due consideration, and therefore failed to convey the impression he desired. If upon comparing my comments herewith with the article you feel that they are justified and will be of value to your readers, please publish this.

In the third paragraph of the above article the author states that there is scarcely a public school in the United States today that is not absolutely safe for our children. I feel very safe in saying that this article, if called to the attention of any fire prevention engineer of broad experience, would be characterized as being grossly untrue. An illuminating discussion of this subject appears in the July, 1919, issue of the *National Fire Protection Association Quarterly* under the title of "Fire Protection for Schools." It is particularly important that the reader of so reliable a publication as SCIENTIFIC AMERICAN should not be thus misled, because the main obstacle to securing fire safety in school buildings is the lack of knowledge on the part of the public. It is hard enough to overcome ignorance without having to combat misinformation from journals of standing.

I strongly suspect that the discussion of electrical hazards is not based upon sufficiently sound information or long enough experience. Accidents caused by electricity will vary widely, according to the nature of the industry and the use and control of electricity. With standard equipment, and a reasonable standard of safeguarding, accidents caused by electricity will not only be few, but they should cause little time loss or compensation costs, except, of course, in the case of the electrical industry itself. Even here, such accidents can usually be kept down to a small proportion of the total, both in number and loss occasioned.

The incident cited, in which an employee attempted to light his cigarette from an arc drawn by opening a switch under load, if true as stated, shows sub-standard equipment, because the ordinary type of open knife switch should never be used on such voltages as 16,000. Disconnecting switches should be used and they should be so mounted and arranged as to be opened by a long pole.

The reference to some one working on the line and throwing an extra heavy load on the circuit is obviously an error.

Later in the article, the author tells of an accident occurring from an arc caused by the opening, under load, of a disconnecting switch of a 23,000 volt circuit. I do not understand the explanation, because it is stated that the operator "tripped the switch," which, of course, means that he opened the oil switch, killing the circuit. In other words, he either must have opened the disconnecting switch on some other circuit, or else the oil switch failed to work and did not break the circuit as he supposed. In any case, had the disconnecting switches been properly arranged and separated, with proper marking, the accident could scarcely have occurred. The speed with which he opened the disconnecting switch would have no bearing on the matter.

R. P. BLAKE.

Philadelphia.

Wonders in Steel Forging

The Rôle of Giant Hydraulic Presses and Huge Steam Hammers in Large-Scale Blacksmithing

By A. R. Surface

THE engravings show some very remarkable instances of steel forgings made in France. For the cruisers "Virgniaud," "Danton" and "Voltaire" thirty shells were forged for the turbines, while a number of similar shells went into the steamer "France." An idea of the sizes may be gathered by comparing with the standing men. Among the shells forged for the latter vessel, were one or more plain cylinders having an outside diameter of 10.824 feet and an inside diameter of 10.168. This means a wall thickness of about 3.9 inches. The shell length was nearly 11 feet. The weight of a big fellow like this is 54,800 pounds. While the shell is quite plain, the great length and diameter presented features of difficulty in forging. Another form of shell is one having the same internal diameter all the way through, but a decided variation in the outside diameter. Examples of this are to be seen in Fig. 1. One or more shells of this type were forged for the "France," in which the larger outside diameter is quite equal to the external diameter of the former forging, viz., 10.824 feet. The internal diameter was made 6.855 feet, corresponding to which is a wall thickness of 1.985 feet. This is a very heavy wall indeed. This thickness was maintained for about 2.3 feet of the total length of about 5.3 feet. The thin part of the shell was made nearly 5 inches thick. We have a very remarkable example of the wonderful forgings being turned out in France. This piece weighed 88,000 pounds—quite a chunk of metal.

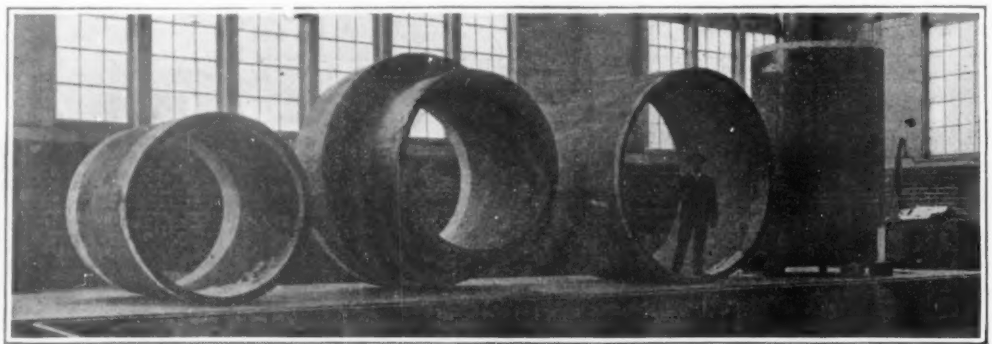


Fig. 1. Marine parts made in France whose size and shape constituted a notable problem in forging technique

Perhaps more remarkable yet are certain rings forged by the same concern. The metal was a special nickel-chrome steel. The rings were of considerable diameter relative to the length. The outside diameter was nearly 11¼ feet, the thickness of metal about 5.2 inches, and the length of the ring only 17.71 inches. The work began with a heavy-walled ring of much smaller size, but whose length was just the same. There were six heats in all. The great difficulty in producing the final result centers on the maintenance of perpendicularity to the axis. All the examples illustrated and described so far were forged in the hydraulic press. To these examples may also be added the great shaft for a cruiser shown in Fig. 2. The advantages claimed for the hydraulic press are: Absence of vibration, superior mechanical result, and rapidity and precision in forging. Further, this means of heavy forging lends itself to the forming of the work on a mandrel. Tubular pieces may with advantage be handled by the press. However, the great French works at which the foregoing forgings were produced has not entirely abandoned the percussion idea. They still have three rather good sized hammers of 100, 30 and 20 tons capacity, respectively, besides a large number of smaller units. At last accounts, the works contained, however, eight hydraulic presses whose capacities range from 600 to 8,000 tons.

However, France is not the only country by any means where big presses have come into use. Just prior to the outbreak of the Great War a giant forging press was built for one of our great plants where railroad equipment is manufactured. This press has the capability of developing a pressure of 9,000 tons from its main cylinder. It was built to forge car wheels from hot blanks of steel at the rate of 40 per hour. It has, however, turned them out at a speed of one per minute. The total stroke of the apparatus is 32 inches. Naturally, it is only in the latter part of the stroke when the full power will be required. During the earlier part of the stroke, operation is secured by a water pressure of merely 30 or 40 pounds per square inch. After this, a pressure of 2,500 pounds per square inch may be used all along the stroke. Finally, during the last four inches, this pressure may be doubled. As the big cylinder has a diameter of 72 inches, a machine of such power is a heavy affair. In the present case, the cap is a nickel steel casting weighing 375,000 pounds. The plunger is also of nickel steel. To its bottom is attached the cross-head, a big steel casting weighing 250,000 pounds. This cross-head casting is thought to be a remarkable example of the founder's art, as in the machining no defect was found. The base is also of cast steel.

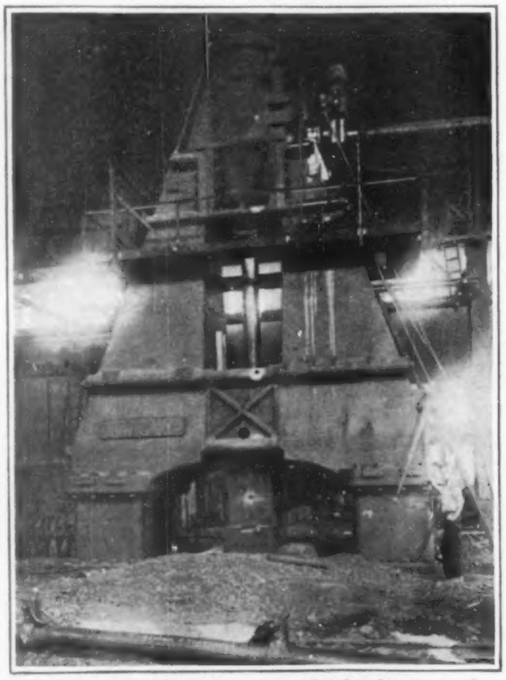


Fig. 3. A double-acting steam forging hammer of American manufacture

The pressure of the press is exerted against the Torsional resistance of four big columns. These are themselves hollow steel forgings, 30 inches in diameter and 33 feet 5 inches long. The compression operation is carried out as follows. The cylinder carried by the cap goes under pressure by the forcing of water into it. This pressure reacts on the plunger and forces it downward. The cross-head with the forming die in place is thus pushed down by the plunger and pressure exerted on the work lying on top of the base. When this pressure comes on, the four cylinders have to resist it. The transportation of this great piece of apparatus across nearly the full length of Pennsylvania involved special problems, and led to the use of a special car with two trucks, one at each end and each containing 16 wheels. There was a connecting bridge frame for the load, consisting of two parallel girders of considerable size.

Another great forging tool was built in the United States, being shipped to the point of use at or near Washington soon after America went into the war. It is not a hydraulic affair. It is a modern machine, however, which is correctly described as a double-acting steam forging hammer (see Fig. 3). At the time it was claimed as the biggest hammer of its type ever produced in the United States. It was shipped to its destination in 14 railway cars. There is a 96-inch stroke and the cylinder has a bore of 40 inches. The ram or hammer is 51 inches wide, 72 inches high, and 66 inches deep, front to back. This ram is notched to provide for the handling of a steel die 72 inches front to back, 41 inches wide and 28 inches high. This itself is quite a piece of metal and is said to weigh 10 tons. The combined weight of falling parts is about 80,000 pounds. A steam pressure ranging from 100 to 150 pounds per square inch was in contemplation. When operating under full steam pressure, the blow delivered is said to amount to 8,000 tons. The anvil, steel anvil cap and steel die together weigh 350 tons.

The standard type of hydraulic press has four tension columns. These hold cap and base apart and resist their further separation when the pressure is on. Ordinarily, such presses have their columns in a vertical position. But this is not essential. Some years ago a Philadelphia concern built a 2,000-ton extrusion press which had its columns horizontal. A notable thing about this press is that the pressure chamber is heated to avoid chilling the metal too much when it goes into position for the extruding operation. The metal has at this time a temperature of 1,650-1,800 degrees Fahrenheit. If the pressure chamber where the metal is put should be cold, the chill would affect the surface of the metal at once. There would thus be both hard and soft metal in the same mass which would doubtless give rise to irregularities in the extrusion. In order that the pressure chamber itself shall withstand the heat and in addition not lose too much tensile strength, a special steel is used for its walls.

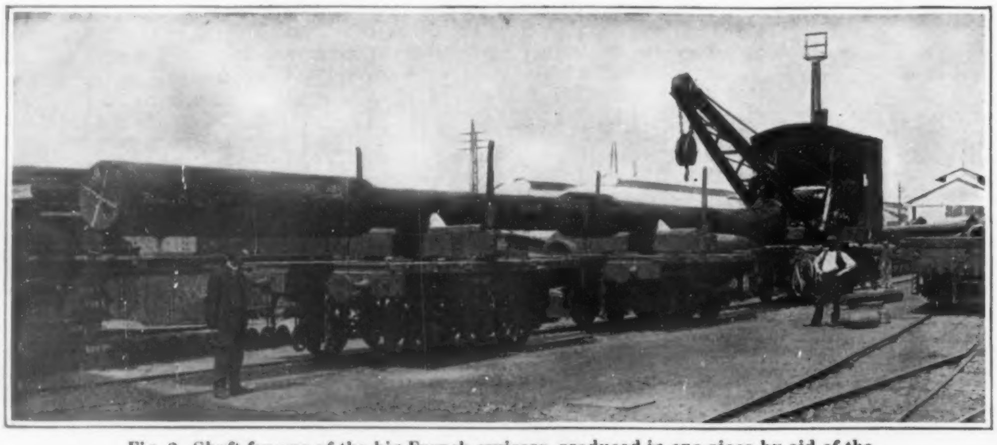
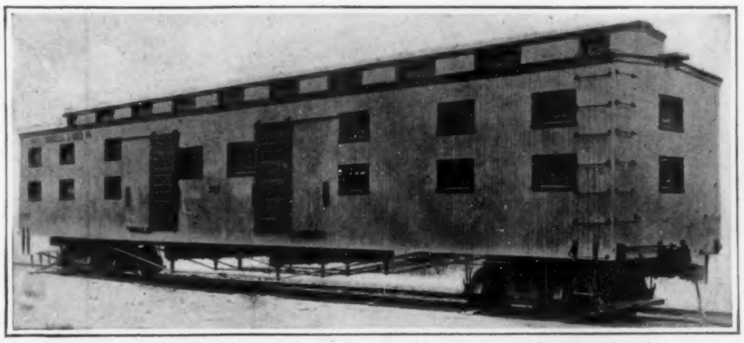


Fig. 2. Shaft for one of the big French cruisers, produced in one piece by aid of the hydraulic press

Bunk Cars That Satisfy Labor

THE ever-growing scarcity of labor has resulted in a demand for better working and living conditions that is not to be denied. Indeed, from time to time these columns have illustrated and told about the model camps and living accommodations now being used by contractors, lumber companies, manufacturers and others in taking care of their labor and trying to make it as permanent as it can be made.

In the accompanying illustration we have another interesting case of the excellent living conditions which prevail in almost every walk of modern industry. In this case it is one of the bunk cars of a western lumber company. A large number of these cars go to make up a long train—a veritable village, to be sure—which moves from place to place as the army of lumbermen is shifted through the great lumber region of the Pacific Northwest. Each car contains comfortable beds, abundant light, and excellent ventilation facilities. This type of bunk car is a worthy improvement over the old bunk car which was no more than a regulation box car fitted up with crude bunks and having one or two side windows for ventilation. Each new car accommodates 28 workmen in comfort.—By *C. L. Austin.*

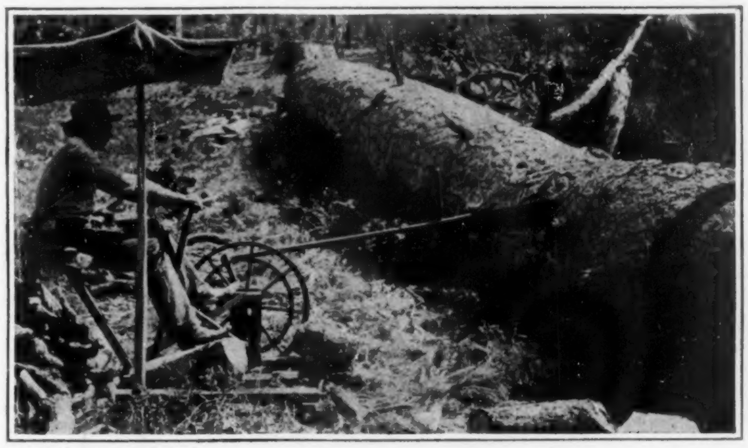


This bunk car, which is a unit of a long train, accommodates 28 lumbermen in the utmost comfort

Still Another Method of Sawing Big Trees

IT seems that there is no end to the methods developed for simplifying and easing the work of sawing big trees. Within the past few months these columns have had numerous ingenious ideas along these lines, some from abroad and many from Americans, some calling for gasoline power and others using good old man power.

Now it is L. H. Porter of Oregon who has improvised an ingenious arrangement which is shown in the accompanying illustration. Mr. Porter makes use of a hinged upright with cross handle-bar which, when worked back and forth by the operator, transmits the power to a large cross-cut saw through gearing and levers. In this manner it is claimed that the biggest logs can be cut up by one man without undue effort.—By *Alfred Langville.*



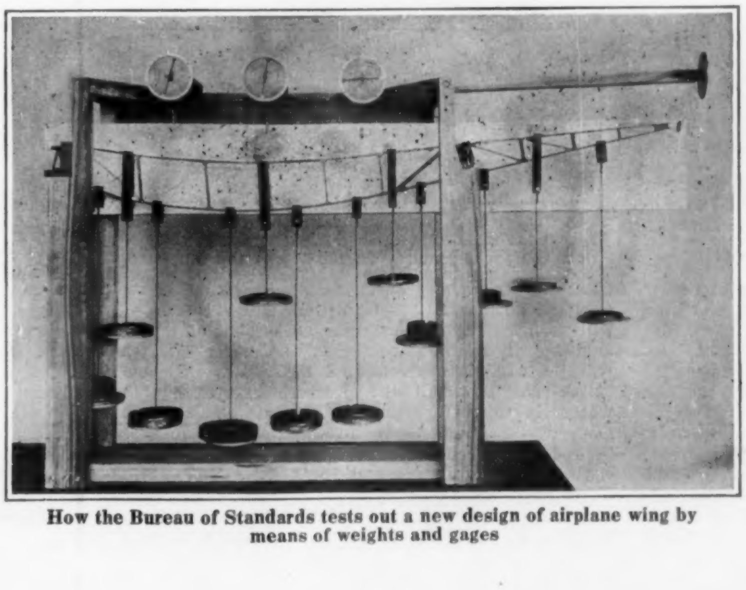
Rocking the handle back and forth causes the big cross-cut saw to go through the log in quick time

Speeding Up Reforestation with the Planting Board

ALTHOUGH planting seedling trees by hand is laborious and expensive, annually the Federal Forest Service has to reforest between 10,000 and 12,000 acres of land denuded by fire of tree resources. Forest Service employees as well as natives in the various national forest regions gather the cones from the trees before the seeds drop out, often collecting large caches of cones stored away by the pine squirrels who have hidden the tree fruit away for winter use. Subsequently at the various forest stations, the cones are heated in warm rooms so that ultimately they open and yield up the seed concealed within them.

After being cleaned and graded the seed is planted in nursery beds. When the seedlings are well developed they are dug up and transplanted. To minimize the labor involved in setting the individual seedlings by hand, a planting board is used which is threaded with the seedlings and then placed on the prepared seedbed so that one entire row of baby trees is imbedded in the soil in a single operation. Sometimes when the infant trees are a little larger they are again transplanted, the purpose being to develop plenty of stocky growth and hardiness during the first two or three years of the seedlings' lives so that when set out in the forest proper they will survive and develop into stout, sturdy trees. —By *G. H. Dacy.*

This planting board enables the foresters to set out a row of seedlings in a single operation



How the Bureau of Standards tests out a new design of airplane wing by means of weights and gages

A Moonlight Rainbow

NEARLY every one has seen one or many rainbows. But how many have seen a rainbow at night? Yet it is, of course, quite possible for the rays of the moon, reflected from a rainstorm, to form a rainbow in exactly the same manner as the sun's reflected rays form the ordinary rainbow.

The writer, while a passenger on the U. S. Army Transport "Kilpatrick," bound from San Juan, Porto Rico, to New Orleans, La., witnessed, at 8:30 P. M., on October 10, 1919, in latitude 20° 30′ N., longitude 72° W. (just north of Cape Haitien, Haiti) a large and distinct rainbow, due entirely to the rays of the moon. The rainbow, which was west of and in front of the ship, was complete, toching the water at both ends.

The fact that the ship was headed directly into the center of the rainbow and of the storm upon which it was reflected added a portentousness to the already weird and beautiful effect. The rainbow continued to precede the ship for about thirty minutes, and was taken by the superstitious on board as a favorable omen, especially as the ship was at that time in the same waters in which several ships, including the ill-fated "Valbanero" met disaster in the severe storm of a month previous.—By *Lieut C. C. Harshman, U. S. A.*

Something New in the Way of Airplane Metal Ribs

EXTREME altitudes—the objective of Major R. W. Schroeder and aviators of like ambitions—are not to overshadow another problem of aeronautics, that of multiplying the speed range of airplanes. A new type of airplane rib developed by the U. S. Bureau of Standards, by varying the angle of attack, is capable of making greater speed than hitherto possible with the prevailing wings.

Described as the Parker variable-camber wing, the newly-designed equipment recognizes the principle of construction that if the angle of attack can be efficiently varied from a very small to a very large angle, a wide range of speeds is possible. The properties of the type of wing usually seen are held responsible for the restricted speed of airplanes.

Among the features of the rib structure of the Parker variable-camber wing are: Deformation regularly with the load up to the unit flying load, then remains rigid under further applications of weight, being strong enough to stand up under several times its normal load without failure. Simple, foolproof and easily manufactured are the virtues claimed for the wing. Metal construction is necessary in the new type of rib; other portions of the machine such as spars, bracing wires, and struts are not altered. The essential parts of the new wing are: channel-shaped strips forming upper and lower surfaces of the rib between the spars; compression links are of channel section also and fixed to outer channels by pins, allowing necessary angular motion between links and strips; the tension links are flat strips of steel attached to the same pins which carry the compression links.

A radical departure from the prevailing type of wings, these links in streamline position carry no load, but in a lifting attitude they straighten out and make a truss of the rib, thus preventing further deformation under loads. The links in the first two and last two panels are slotted to permit of the insertion of reserve links. A tail piece is fixed in shape, riveted to the upper strip and constructed to slide over the rear spar. A spring is placed between the rear spar and the tail piece, this spring being used as a tension attachment to the rear spar and the front compression member of the tail piece.—By *S. R. Winters.*

Left: View of entire dam from downstream, with central sections tilted. *Center:* A close-up of the super-dam, showing the tilting sections. *Right:* Water flowing over the dam via the first six of the tilting sections

The elastic dam, crowned with metal sections that tilt successively as the backwater behind the dam approaches the danger point

Baltimore's Tilting Dam

A Structure That Opens Automatically When It Has Backed Up Too Much Water

By J. F. Springer

THE construction of a dam is not always a case of simply building a structure competent to resist the maximum efforts of the body of water at its back. The engineer may be called upon to do more than that. A possible case in point is the tilting dam at Lock Raven a few miles northeast of the City of Baltimore. The water department of the city desired to increase the capacity of the reservoir-lake Lock Raven in order to meet the needs of the population. It was proposed some years ago to erect a dam with a fixed crest 188 feet above average mean tide and a movable crest 4 feet higher.

All this is simple enough; there are various means of increasing the height of a dam temporarily. However, further upstream was located a big manufacturing concern which used for power purposes more or less of the water before it reached Lock Raven. The elevation of the tail race at the manufacturing plant was 196 feet above average mean tide. With a dam a few miles downstream impounding water back of a crest at elevation 192, the manufacturing concern foresaw possible interference with the effective head of water used by it. The total margin between the two levels was only 4 feet, which would be diminished by the depth of water over the crest. Upon going to court, the manufacturing concern lost. At the same time, the City of Baltimore made a concession to the extent of putting upon the masonry dam, with a crest at elevation 188, a super-dam which goes into and out of action automatically to prevent an excessive rise of water above its own 4 feet of height. That is to say, along the crest of the masonry structure twenty-seven separate and distinct tilting dams have been constructed. With these twenty-seven dams standing in normal position the Lock Raven Dam has its crest at elevation 192. If the water rises 1.5 feet higher, six of the twenty-seven units automatically tilt, the result being a lowering of the crest through this region. If this does not relieve the situation and the water level over the dam continues to rise, then when the level gets to elevation 194—that is, two feet above the maximum crest—nine more units automatically tilt. If notwithstanding this opening up of passage-way, the water goes on up six inches higher—that is, to elevation 194.5—then four more units tilt. Similarly, four units tilt at elevation 195 and four at elevation 195.5. All twenty-seven have by this time gone into tilted position and are assisting to pass the water along. It will be seen that very elaborate provisions have been made to protect the manufacturing plant and perhaps other interests upstream.

Up to some seven years ago Baltimore impounded a part of the waters of the valley of the Gunpowder River by a stone dam 25 feet high. This dam created a small reservoir which was called Lock Raven. Its capacity was only about 510,000,000 gallons at best. Because of the continued deposition of silt, the capacity fell off more and more. In 1900 it had dropped to about one-third of the original. However, by dredging, the reservoir was kept in commission. The new dam is located something less than half a mile farther upstream than the old one. With its crest at elevation 192, the new structure makes of Lock Raven a lake of 620 acres with a storage capacity in the neighborhood of 2,000,000,000 gallons. This is estimated as sufficient storage, if both clear and turbid water are used, to guarantee a daily supply to the city of 90,000,000 gallons.

However, the authorities are looking ahead, and have constructed the base of the present new dam of such width as to permit an increase of its effective height to elevation 305.0. This is 113 feet above the crest of the new super-dam. The lake back of the dam would then be increased to an area of about 9,500 acres with the capacity of 142,300,000,000 gallons.

The general principle of action of the tilting dams may be understood with the aid of the sectional diagrammatic view shown in Fig. 1. The masonry dam

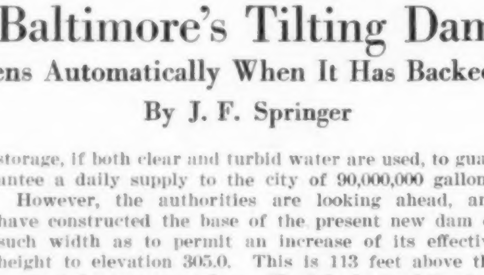


Fig. 1. How the tilting sections stand when in the closed position, the pressure against the face AB not being sufficient to rock it over

is surmounted by a structure which is, in section, of a triangular shape. This is pivoted at C. The upstream face is at AB, which presents an inclined surface at about 40 degrees to the horizontal. Under ordinary circumstances, the center of gravity, not shown in the figure but to which we may refer as E, lies upstream from a vertical line drawn through the hinge. Consequently, the tilting dam will of its own weight rest quietly upon the crest of the masonry structure. As the water rises above the level of the point A, its weight at first will be exerted solely in the direction of pinning the movable dam down upon the masonry crest. But after a time, the water will lend no aid to this pinning-down action. The thrust of the water

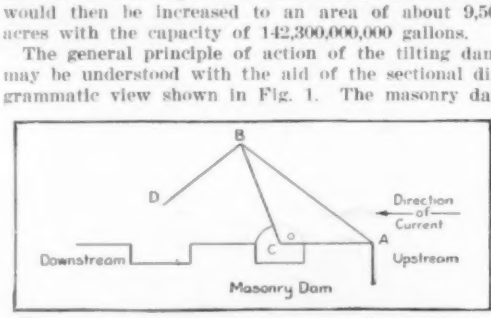


Fig. 2. As soon as the water behind the section reaches the head for which the section is set, it tilts until the bar D grounds on the top of the masonry

due to its weight may be viewed as a pressure exerted over the surface AB and perpendicularly to it. We will now, for the moment, take no account of the triangle's own weight. Looking at the matter thus, the triangle ABC becomes a kind of see-saw supported at C. At first, all the pressure exerted by the water is applied between A and E. But as more water comes into action, there is pressure beyond E, between E and B. This will operate against the pressure between A and E. After a time, as the water rises, there will be as much perpendicular pressure on AB above E as below it. There will be no overturn as yet. The pressures are evenly balanced, and the one below E is assisted by the weight of the super-dam. But, as the water goes on up, a time will at last come, if the triangle projects upward far enough, when the perpendicular pressure on AB above E will just equal the same pressure below E. The movable dam is now about to tilt. It is possible so to adapt the form of the triangle and so to distribute the weight of the structure that the dam will tilt at a predetermined level of the water. That is just what the designer, Mr. V. Bernard Siems, Pitometer Engineer, Baltimore City Water Department, has done. Beginning with a type adapted to tilt at 5.5 feet above the masonry crest, he has added others adapted to tilt at 6-inch intervals above that level until a tilting point 2 feet farther up has been reached. In fact, he developed two groups to tilt at the second tilting level.

One must emphasize the point that the tilting takes place automatically. The several classes of dams go into action of themselves without any attention from watchmen, operators or the like. It is the weight of the water and dam and the shape and arrangement of the parts that control. The weight of the water is the only one of these that varies. And it is precisely its variation, expressed as level, that it is desired to control. Probably, the velocity of the flow may have some effect, and also the presence of driftwood. But, disregarding such things, the dam seems a reliable structure which will act as desired when the conditions require it.

In the case of the super-dam a typical unit weighs 1,212 pounds. It is constructed in part of wood and in part of metal. Water-logging may, it is estimated, cause the weight to rise to 1,400 pounds. On this particular type of unit, the center of gravity lies 8½ inches upstream from the hinge and 1 foot 7 1/16 inches above the masonry crest. If we reduce the 8½ inches to feet and multiply the result by 1,212 pounds, we shall get 859 foot-pounds for the moment which the water will have to overcome before tilting will take place.

When the tilting does take place the movable structure turns on C and the foot D coming into contact with the top of the masonry dam, or perhaps the bottom of a depression in its crest, halts the movement. Water can then flow over and through the structure to the downstream side of the general dam.

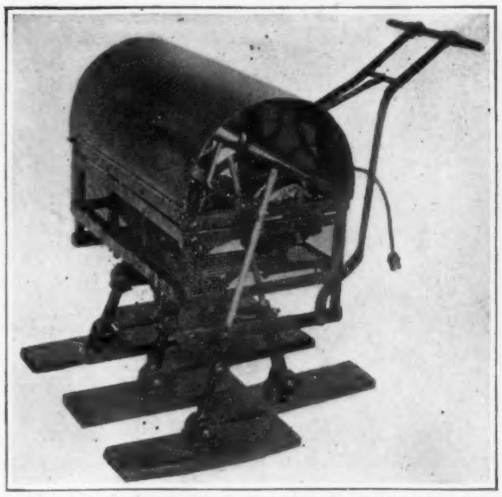
Since the dam has been finished, there have been high water conditions. Types adapted to tilt at the first two levels have actually done their tilting. In many cases where actual tilting has occurred, the tilt has taken place somewhat earlier than the design contemplated. Thus, the tilting has occurred when the water was still 4 inches short of the proper level; in other cases, the action has taken place as early as 7 inches ahead of the level. In explanation of this, Mr. Siems says in effect that as the water goes down and gets near the level of the masonry crest, foreign matter lodges at the toe of the super-dam, so that when it drops back to normal position, it seats itself on this accumulation and rests in a position forward of normal. Similarly, the warping of timbers in the super-dam will have the same effect. Under both conditions the super-dam is in a position where the head necessary for tilting is decreased. On the other hand,

(*Continued on page 22*)

A Silage Tamper That Walks as It Works

IN order to convert fodder into silage, certain necessary chemical changes must take place in the silo. Investigation has proved that such changes cannot take place to the proper degree if the air contained in the loose fodder is not expelled at the time the silo is filled. And so a very necessary operation in the filling of a silo is to tamp down the fodder to expel the pockets of air, and it has remained for an American inventor to develop a machine that tamps the fodder by walking and stamping on it.

The walking tamper appears in the accompanying illustration. When this machine is placed in the silo, the hood, handles and feet are removed. The frame then stands 19 inches high, 25 inches long, and 14 inches wide, so that it will pass through any opening 20 by 16 inches. The tamper is operated by a one-third horse-power electric motor which drives the tamping mechanism. The machine is supplied with six feet, of which three are advanced at the same time when taking a step. This gives it a stability that could not otherwise be obtained, according to the inventor. Two of these feet measure 4 by 15 inches, while the four others measure 4½ by 15 inches. One of the outer feet has a slight curve on its outward edge, so that it can work close up to the inner wall of the silo. By means of a simple yet ingenious clutch, the feet are dropped as soon as the crank passes beyond the center, thus giving the feet a stamp that can be compared to a man stamping as he walks. The compressive force thus exerted is many times greater than if the machine simply walked as a man does. The speed can be adjusted to suit the conditions, but the normal adjustment calls for 21-inch steps thirty times in a minute. It is figured that the area of a 12-foot silo can be covered four times in five minutes.

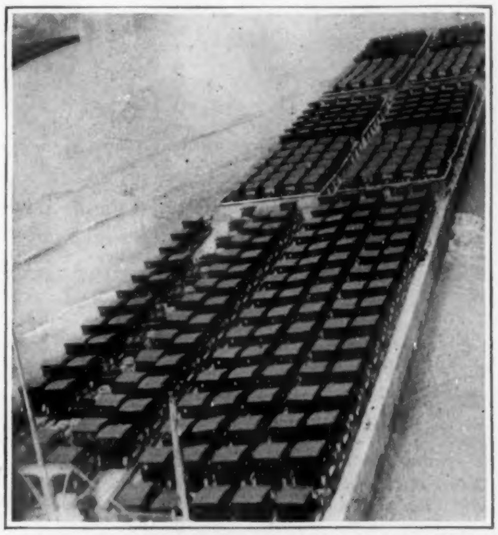


This mechanical tamper walks about inside the silo and tamps down fodder

A Load of Automobiles

WE have all read how automobile and truck manufacturers, driven to distraction by the repeated and lengthy rail tie-ups which prevented them from making deliveries, resorted in many instances to the expedient of delivering their machines under their own power. In some cases cars and trucks that were badly wanted at their destinations have been driven hundreds of miles in this way. But as the distance between the factory and the prospective user increases, this method of making delivery becomes more and more a desperate remedy, and calls for a substitute. The photograph herewith, taken on the Ohio River at Cincinnati, shows that where there exists a navigable stream such a substitute is not lacking—though in fact it may not always be an actual substitute, but rather an aid to the more tedious process of road-delivery.

The cars shown on this huge tow were made in Detroit, and were all consigned to Cincinnati and points within reasonably short distances thereof. Just what route was followed in their delivery we are not definitely informed, though we understand that they were shipped from Detroit under their own power to points on the Miami or Wabash Rivers where they could be loaded on barges for towing to Cincinnati, whence they were finally distributed under their own power. It is evident from the width of the tows that the canals connecting these rivers with Lake Erie were not utilized. A lake haul to Ashtabula or some nearby point, followed by a drive to Pittsburgh and floating thence down the river, would have been another alternative. Whatever the route taken by this first impressive cargo, however, the undertaking was so successful that it is planned to follow the same procedure to deliver a quantity of cars that have been ordered for the Memphis, Vicksburg and New Orleans districts. It seems fairly obvious that when we begin to get river transportation in such large blocks and for distances approximating a thousand miles, we have a method of delivery that may be expected to hold its own even after the railroads get back to a normal basis of operation. Lower freight bills, cheaper and easier packing, and a good many other factors seem in favor of shipping automobiles in this fashion—when the water route exists.

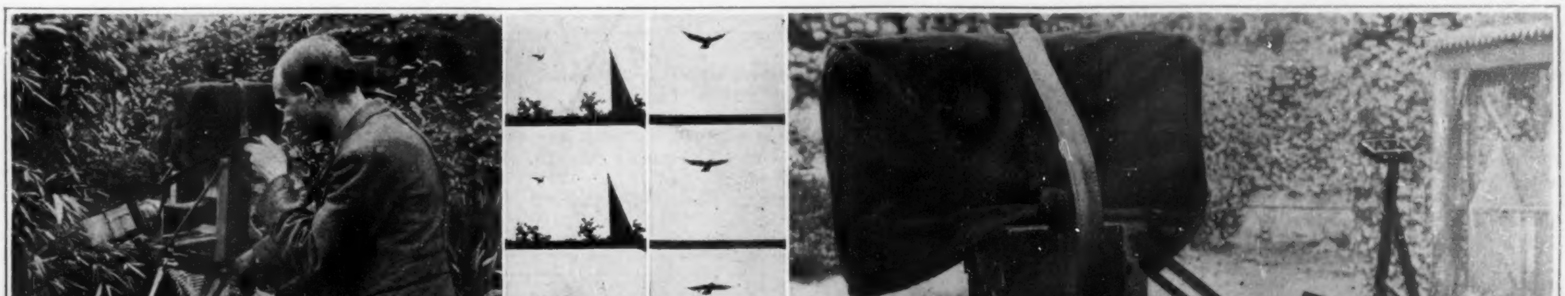


A huge tow of automobiles shipped in this fashion in the absence of rail accommodations

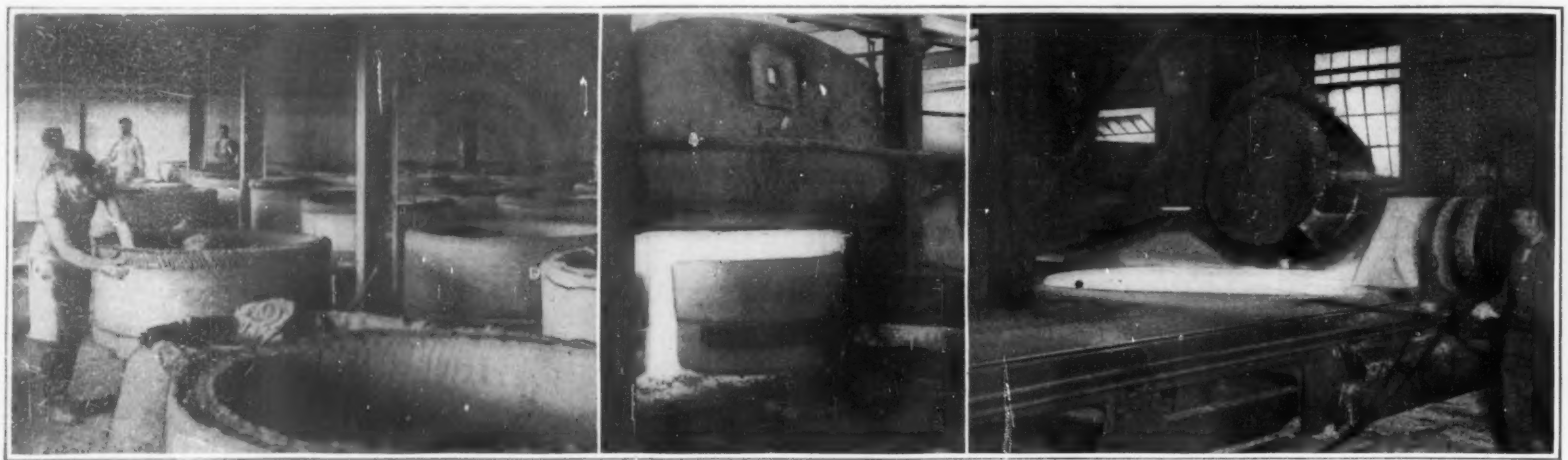
Aiming a Mirror to Film Moving Objects

BY aiming a mirror in conjunction with the lens, instead of the entire camera, as is usually the practise, a French cinematographer, M. George E. Labrely, has succeeded in making motion pictures of rapidly moving objects. Heretofore the motion picture camera generally used has not been adapted to the filming of rapidly moving objects, such as a bird in flight and a rabbit on the run. In the Akeley camera, which has been described in these pages, the entire camera with its lens can be readily and quickly traversed and tilted to follow moving objects. In this respect, and in several others, the Akeley camera has been quite unique. But M. Labrely has introduced a new idea which promises to contribute much to the screen in the way of subjects heretofore held to be impossible for the cinematographer with the usual camera equipment.

It will be noted in the illustrations of the new camera arrangement that M. Labrely moves a mirror while the camera remains fixed. In this manner he has only a small weight to shift, and the movements can be many times more rapid than if the entire camera had to be shifted. The arrangement comprises a flat mirror held at 45 deg. angle in front of the lens, and supported by a long handle, the mirror reflecting the image into the long-focus lens connected with the camera by means of a long flexible bellows. The flat mirror can be aimed in any desired direction, and the image is reflected into the lens which remains stationary. The long handle also carries a simple direct-view finder so that the mirror can be aimed at any desired object. The Pathé type camera used in this case has hardly been modified to take care of the new arrangement, except for the drop board.



Two views of the ingenious arrangement for taking motion pictures of rapidly moving objects, and two strips of film made in this manner



Left: Preparing clay pots for fusing the glass-making materials. *Center:* Removing the pot of molten glass from the furnace. *Right:* Pouring from the pot on to the molding table for rolling into plate glass.

Three important stages in the manufacture of plate glass

How Plate Glass Is Made

The Tedious Process by Which Modern Technology Has Been Able to Make Glass without Blowing

By Ralph Howard

GLASS making, one of the oldest of industries, has undergone a startling extension of late years. Not so long ago it would have been easy enough to catalog all the types of glass which were produced. But today there are the familiar blown glasses for windows and other ordinary purposes. There is plate glass, a relatively modern development which does not call for the services of the blower. There are wire glasses that resist shattering to an unbelievable extent. There are figured glasses that let in light but exclude vision. And there are other tricks of the glass-maker's trade too numerous to mention. But perhaps of greatest interest is the apparently simple but really most complex process by which glass is rolled directly into sheets, without the blowing that for so many centuries was considered essential. This is the story of plate glass.—THE EDITOR.

GLASS blowing is one of the oldest industries in the world; it has been a feature of the industry of practically every country of importance from the dawn of history. It is, therefore, not to be wondered at that when preparation of glass in flat sheets for windows and mirrors was first undertaken, the methods followed were the same as those which had been familiar for so many centuries. The apparent absurdity of preparing first in the form of blown bubbles and then in the form of cylindrical sheets, glass which was desired in flat form and which had to be rolled out flat at considerable trouble and risk, was no absurdity at all if we look at it historically. And if we consider that even today sheet glass can be made in this way of reasonably good quality and at lower cost than by any other method, we see a vindication of those who have stuck to the glass-blower.

But the plate-glass industry of today demonstrates that it is not true, as so often carelessly asserted, that glass cannot be produced without blowing. It is more expensive to produce it without blowing, but it can be done, it is done, and a better product is thereby secured. The methods of plate-glass manufacture, however, are not nearly so well known as the older technique which was represented on a cover of the SCIENTIFIC AMERICAN within the past six months.

Plate glass was first made in France in 1688; the first glass rolled without blowing in the United States dates back to 1860 only, and was an unqualified success for the first time at an even later date. So plate glass is really a modern product.

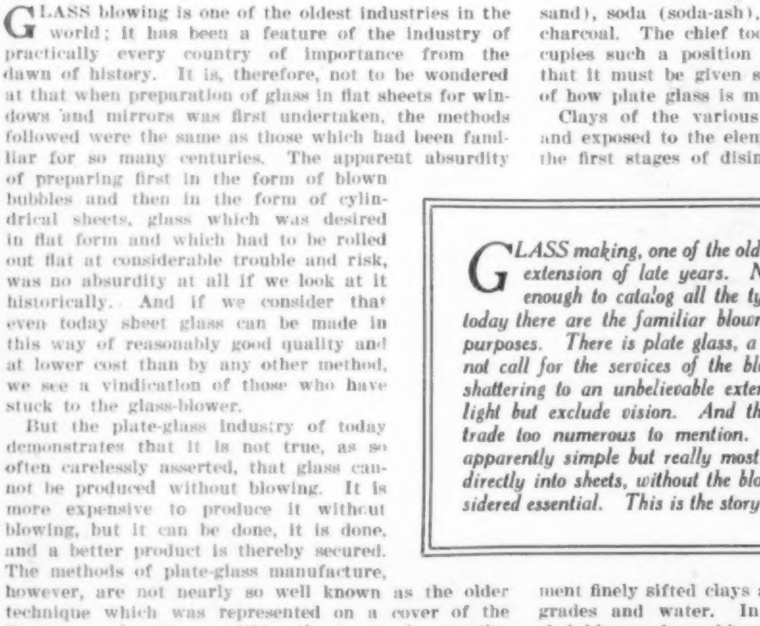
The chief ingredients for plate glass are silica (white sand), soda (soda-ash), lime (limestone), arsenic and charcoal. The chief tool is the clay pot, and this occupies such a position of dominance in the industry that it must be given separate attention in any story of how plate glass is made.

Clays of the various qualities required are mined and exposed to the elements for a time to bring about the first stages of disintegration. At the proper moment finely sifted clays are mixed with coarser, burned grades and water. In this manner the chances of shrinking and cracking are reduced. The mixture is kneaded in a mill, kept sometimes as long as a year in storage bins to ripen, and finally is passed through the laborious process of treading. And if primitive methods have been eliminated in the supplanting of the human glass-blower by the mechanical glass-roller, they have triumphed in the manufacture of the pots. No machinery has been invented by which the same satisfactory plasticity can be given the clay as by the tread of the bare human foot. The clay must be tediously treaded and treaded, many times over; without all this care, when the molten glass goes into the pot some of the ingredients of the latter would be fused out, and the entire effort involved in making both the pot and the glass would go for nothing.

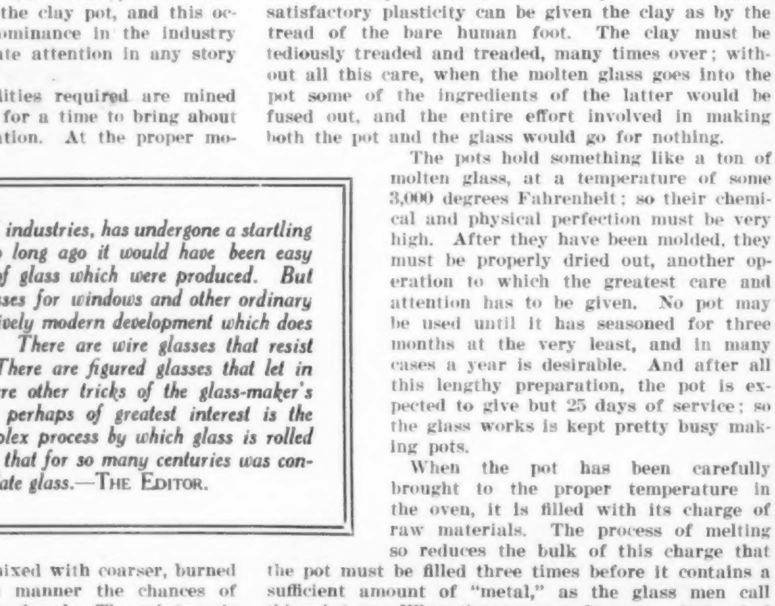
The pots hold something like a ton of molten glass, at a temperature of some 3,000 degrees Fahrenheit; so their chemical and physical perfection must be very high. After they have been molded, they must be properly dried out, another operation to which the greatest care and attention has to be given. No pot may be used until it has seasoned for three months at the very least, and in many cases a year is desirable. And after all this lengthy preparation, the pot is expected to give but 25 days of service; so the glass works is kept pretty busy making pots.

When the pot has been carefully brought to the proper temperature in the oven, it is filled with its charge of raw materials. The process of melting so reduces the bulk of this charge that the pot must be filled three times before it contains a sufficient amount of "metal," as the glass men call this mixture. When the proper molten stage is reached the pot is lifted out of the furnace by a crane. A careful skimming removes the surface impurities, and the pot then is swung overhead to the casting table. The side of this table is lined with adjustable strips, which may be made as high as desired, or as low, to

(Continued on page 24)



The polishing process, using felt buffers and rouge



Removing the plate of glass from the plaster bed after the polishing

Protection for the passer-by from flying fragments of the pavement that is being broken up

Protection from the Ditch-Diggers' Barrage

A HANDY device shown in the accompanying photograph shields pedestrians and windows from being struck by flying pieces of stone that result from breaking through the cement sidewalk or the concrete roadway for the purpose of installing lighting conduits, repairing water connections, etc. It consists of a canvas supported by four pieces of pipe, the uprights being kept from tipping over by heavy circular metal bases. The canvas completely encircles the section of the roadway on which operations are being conducted, and insures that the inevitable bombardment of flying fragments shall endanger no innocent bystanders. The canvas can be removed from the piping and the latter quickly taken down and bundled up for transportation to a fresh scene of activity.—By *A. R. Surface.*

A Keyboard for the Violin Novice

THE beginner with the violin has difficulty learning to finger the instrument properly to strike the desired notes. This would be all very well if, like the struggles of the novice in algebra or with the bicycle, the learner's infelicities affected nobody but the learner. With the violin, however, this is not the case, inasmuch as everybody within earshot must perforce listen to the raucous results of the student's mishandling of the instrument. To eliminate this nuisance, a device has recently been invented to aid the pupil as well as his neighbors during the trying period when the notes are struck upon the unidigital search system. The invention in question is really a keyboard for the violin. In consists of a curved board which is fastened over the neck of the violin, covering the finger board. On this are cut twelve notches over each of the four strings, and through these are passed aluminum studs which, when pressed by the fingers, lightly depress the string below and give the required tone.

In this way the student may learn the fingering of the violin exactly; and after this has been acquired the keyboard can be discarded and the fingering done directly on the finger board. If necessary, it would be possible to write the names of the keys on the studs for very small children. The keyboard does not in any way interfere with the strings, and it may be removed at any time. The inventors have tried out the device with a number of beginning students, and believe that its use will save at least six months of training.—By *A. H. Kolbe.*

Violin equipped with a "keyboard" for the aid of the beginner, and a student using the instrument with this attachment

Powdered Fruit Juice

ONE of the newest fruit products is powdered lemon juice. It is pure juice reduced to a perfectly soluble powder. Details of the process used have not been given out, but it is an adaptation of the well-known spray method of reducing milk to powdered form; indeed, the originaters of the product are powdered milk manufacturers, the largest in the world. The process can also be used successfully with orange juice. The originators intend to erect a California factory for the manufacture of the product.

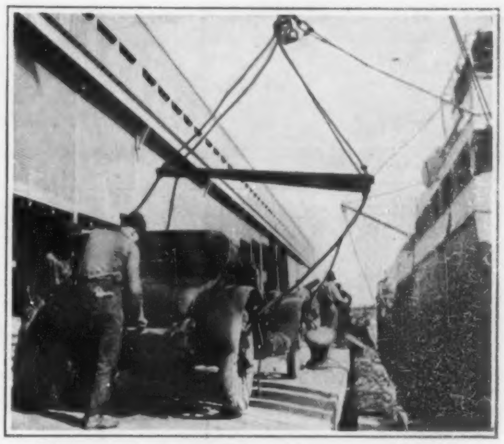
Quality of Water and the Setting of Cement

INVESTIGATIONS made with the object of throwing light upon variations in the setting time of Portland cement have recently shown that divergencies of the kind may certainly be attributed in part, if not entirely, to the quality of the water used in gaging, says a British writer.

For the purposes of the investigation four samples of cement were employed, three of which had been aerated for 14, 24 and 48 hours before use, and the cement was gaged with 10 different qualities of water and weak alkaline solutions. From the results given by these samples it appears that the final setting time of well-aerated cement is accelerated by water having alkaline carbonates in solution, while in the case of distilled water, sea water, and water containing alkaline sulphates in solution the final setting time is not appreciably affected by aeration. Comparison of the results with reference to initial and final setting times shows a distinct lack of uniformity, the only inference being that the chemical reactions occurring in the two stages are somewhat indirectly related.

With the object of ascertaining the influence of gaging water upon the initial and final setting times of cement, without taking into account the effects of aeration, tests were made on samples of cement all aerated for 24 hours and mixed with distilled water, pure and containing different percentages of sodium carbonate in solution. These tests, conducted on briquettes seven days old, gave results showing that increasing percentages of the carbonate caused progressive acceleration of initial set and uniform retardation of final set. The investigation points to the desirability of using distilled water in tests of cement in order that results may not be obscured by variations due to the presence of chemical substances in the gaging water.—By *S. Pelham.*

Costumes of asbestos worn by aviators who took a flaming plane aloft to test the fireproofing process to which it had been subjected



How motor cars are shipped from San Francisco without being crated

Live Loading of Automobiles on Steamships

THE method of handling automobiles employed by a leading steamship company at San Francisco effects a saving of from fifty to seventy-five dollars on each automobile. This saving is effected because it is unnecessary to crate the machines when handled in this manner. The company in question is said to be the only steamship company at San Francisco that can accept autos for export, without the necessity of crating them.

The automobiles are delivered directly from the railroad car and stored in a large bulkhead building. When ready to be loaded on to the steamer, the automobiles are towed to the steamerside by means of an electric tractor. A special device consisting of two pieces of timber and four cables is then attached to the automobile as shown in the photograph, and the car is raised by the ship's tackle and lowered into the ship's hold. The two pieces of timber hold the cables away from the fenders, thus eliminating the possibility of crushing or scratching their members.

This method is also used in taking aboard automobiles belonging to steamship passengers who may desire to take their machines with them.—By *C. W. Geiger.*

Asbestos Suits for Riding the Flames

THERE has been a good deal of work lately aimed at making airplanes fireproof, or at least sufficiently so to enable the aviator to make a landing, after a fire breaks out, and before the plane is burned from under him. Of course this means, among other things, tests. Some of these can be conducted in the laboratory, but final trials must of necessity be made in actual flight, where the conditions of wind are the same as they would be in practise, and where the navigability of the plane during the fire can be demonstrated beyond question. But—what about the aviator who is called upon to make this trial flight with a burning plane—a plane which it is believed will not burn up before he makes a safe landing, but which has never been subjected to a conclusive test on this point?

Aviators are notoriously inclined toward "taking a chance," but nobody would care very much to send a man up to a possible fiery death. So the answer was found in the asbestos suit which is illustrated herewith. Aviators Campbell and Kerwood recently made such a test flight as indicated, at Atlantic City, garbed in suits like this one. To simulate as faithfully as possible the conditions that would follow a tank explosion, the plane and the aviators' costumes were liberally sprinkled with gasoline, and the match applied. Then the flame-wrapped machine took the air, and remained in flight for five minutes. At the expiration of this time the free gasoline had all been consumed, and the fire died out without a trace of damage.

Then the plane alighted, and it was agreed that the fire-proofing treatment had demonstrated its success.—By *Ralph Howard.*

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

This device serves to iron out the dents in automobile fenders

Ironing Out Dented Fenders

CONSISTING of a master yoke, two arms of drop forged steel which are controlled by a long screw with a handle, a new device takes only a few minutes to get a dented fender back to health. These two arms are fastened together with a rolling slide and this permits the arms to spread as regulated by the screw. A cavity in the open end of each arm takes care of the various parts used in straightening operations.

In operation the straightening bar is applied to the upper side of the fender while the steel roll attachment is applied underneath. The bent portion of the fender is forced out or upward when the arms of the device are brought closer together by the screwing motion on the handle. When the extended arms of the cross bar are too far apart, as will occur when the curvature of the fender reaches a certain position, the screw is released slightly and the blocks are moved closer together.

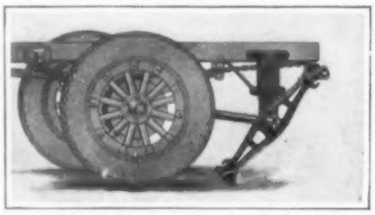
After the blocks have taken out the biggest part of the bump, rolls are attached to the clamp. All forms of fender curvatures may be treated with the device as a variety of rollers are supplied with the arm. A convex roller is used on the outside arm while the inside arm uses a concave roller and they are applied by slipping them into the ends of the arms. When the two arms are brought close together the rollers are worked over the dented surface.

Fenders are not the only part of an automobile which may receive attention from this ironer, as dents in bodies, doors, panels or hoods may be removed as well.—By *Allen P. Child.*

The protector just under the handle protects the latter from the flame

Taking the Hitch Out of Motor Truck Operation

ALL roads are not boulevards, even in these days of excellent roads, and once in a great while the most efficient motor truck becomes stuck in a rut or mudhole or stretch of soft sand. Then, notwithstanding the great strength



Chains and levers such as these get the motor truck out of ruts and mudholes

and surplus power of the modern motor truck, the wheels just spin and spin and the driver is confronted with a nice problem in tractive effort.

In order to overcome just such delays, an American inventor has worked out an ingenious motor truck attachment which forms the subject of the accompanying illustration. In brief, the attachment consists of a pair of levers and chains placed immediately behind the rear set of wheels. The levers are mounted on a shaft which, in turn, is held by sliding members. These sliding parts are provided with a series of holes, so that by removing the pins from the sleeves in which the slides are held, the shaft may be adjusted to the proper height. When needed, the levers should be pinned to the shaft as shown, with one end of each chain secured to the wheel and the other end attached to the levers. When the wheels revolve, the levers are carried to a position approximately at right angles to that in which they are shown and the chains are automatically detached from the levers after the truck has been moved forward. This forward movement of the truck can be repeated any number of times, each time the chains being connected to the opposite end of the levers as they turn. When not in use the levers and chains can be taken down and stored in a tool chest or other convenient place on the motor truck.—By *Alfred Longville.*

Protecting the Coffee Pot Handle

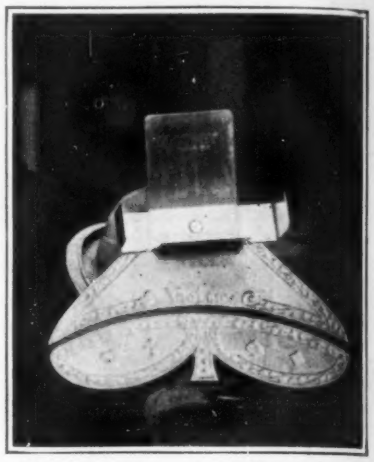
IT happens in the best regulated families—the coffee pot handle pushed too close to the gas flame, and a charred handle remains. This tin protector has been invented to be slipped between the lower horizontal extension of handle and its fastening bracket on the pot itself. It can be easily removed for cleaning and will be found handy in the kitchen.—By *K. H. Hamilton.*

An Extra Hand for the One-Handed Card Player

IN order to satisfy his own longing to play cards and to supply a means for the half a million others who, like himself, have but the use of one hand, Henry Maier of Brooklyn, N. Y., has developed the ingenious little device shown in the accompanying illustration.

With the device invented by Mr. Maier, a one-handed man can shuffle, deal and hold the cards with fair ease and rapidity after a little practise. The machine is so simple in construction, so compact and light that it can be carried about. It is constructed of metal throughout, and contains no springs, cogs or other movable parts to get out of order. And even a two-handed person can find use for this device, when one of the hands is called upon to do other duties such as minding the baby!

The cards to be shuffled are placed in the simple holder shown in the upper part of the illustration. This holder serves to hold the pack in the same manner as one hand, while the cards are shuffled in the usual manner. The cards can then be dealt by swinging the holder about in any desired direction and throwing the card out with the one hand. Once the cards are dealt, the player's cards are picked up one by one and inserted in the curved slot which holds them as nicely as if a hand were being used for the purpose.—By *Albert Valentine.*



This device serves to shuffle, deal and hold the cards with one hand

Here is an idea from Germany—a running-board tool chest for motorists

A Tool Chest Built Into the Running Board

GERMAN efficiency no doubt has prompted a German inventor to work out a complete automobile tool chest which forms part of the running board, as shown in the accompanying drawing. The tool chest, it will be noted, is made as flat as possible so that it occupies little or no space. Recesses are cut in the tool chest in order to accommodate the various tools, so that they are firmly and safely held as the automobile receives the jerks and jolts of a rough road.—By *A. R. Surface.*

A Wringer for the Portable Tub

SINCE the landing of the Pilgrims at Plymouth Rock, wash-day has been known as "blue Monday," probably because of the drudgery incident to washing and wringing dry the clothes.

And as each successive invention has lessened the hardship of washing and drying the clothes, mechanical ingenuity has been thanked a thousand times. First the washing machine displaced the cumbersome scrubbing board and old-fashioned wooden tub, and other improvements followed at brief intervals. Now, thanks to the forethought of a Danville, Virginia, inventor, a simple attachment has been patented for aiding the washerwoman in wringing dry the clothes.

Instead of using all one's strength in drying the garments by hand, this bit of machinery when attached to the rinsing tub reduces the human strength necessary by one-half. Likewise the clothes are dryer by having applied the mechanical device. Instead of the water running down the sleeves of the operator, as is true when the garments are wrung exclusively by hand, the water is drained into the middle of the tub. The handy wringer is simply screwed on to the side of the tub and used as shown.—By *S. R. Winters.*

The wringer hook and how it is applied and used in connection with the usual portable wash-tub


FAIRBANKS-MORSE
Keeping the World's Traffic Moving
THE contribution of Fairbanks-Morse to the development of America's railways has been no small one.
Wherever these steel highways have penetrated, you will find railway equipment manufactured by Fairbanks-Morse helping to keep the world's traffic moving.
Our Sheffield Motor Cars patrol many thousands of miles of track throughout the world. Pumps made by us supply vast quantities of water for railroad use. And Coaling Stations designed, built and equipped by Fairbanks-Morse furnish fuel for locomotives all over America.
Dependability in products for railroad use is a primary requisite. All Fairbanks-Morse railway equipment is built up to the standard of which the Quality Seal of this organization is the index.
Our products include Fairbanks Scales—oil engines—pumps—electric motors and generators—railway appliances and coaling stations—farm power machinery, such as "Z" engines, lighting plants, water systems.
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Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Apparel

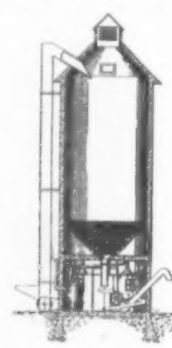
MAN'S GARMENT.—T. GONGORA, c/o Mayo Barrenechea, Box 1052, Los Angeles, Cal. The invention has for its object to provide a garment in the form of a pair of trousers which are reversible, all the seams of the garment being the same on both sides so that when the garment is turned the appearance of the turned side is the same as that of the other side, the pockets being drawn through a slit on the side of the said trousers which are provided with the usual waist band.

Electrical Devices

INCLOSED NON-ARCHING REFILLABLE FUSE.—A. A. WELLS, 42 High St., E. Detroit, Mich. An object of the invention is to provide a simple and inexpensive fuse plug which will extinguish and choke the flame or arc incident to the fusing of the current conducting material. It is also an object to provide indicating means for showing that the fuse has been blown and no longer conducts current.

Of Interest to Farmers

MEANS FOR HANDLING EAR CORN.—W. G. ECKHARDT, De Kalb, Ill. The invention relates to means whereby a farmer may treat ear corn fresh from the field. A more specific object is to provide a storage receptacle adapted to receive ear corn at any time after it is practically

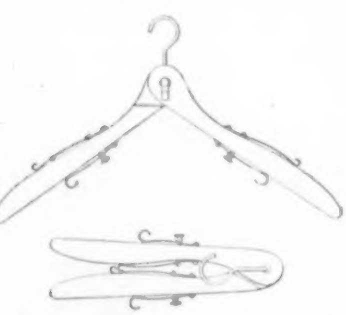


A VERTICAL SECTION OF THE INVENTION

matured irrespective of the moisture that may be contained in it, means being provided in connection with the receptacle to rapidly drive the moisture therefrom. Another object is to provide a receptacle that is proof against mice, rats, and other vermin, as well as serving as a safeguard against molding and rotting.

Of General Interest

GARMENT HANGER.—F. L. OWEN, 1406 Commonwealth Ave., Allston, Mass. The purpose of this invention is to provide adjustable supporting spring clips with tension screws, on a garment hanger, especially adapted for



A VIEW SHOWING THE INVENTION IN OPEN AND FOLDED FORM

light dresses and waists. The device will not only prevent falling off, as is usual with ordinary hangers, but will securely hold without injury, a large number of garments, thus effecting economy both in hangers and space. A further object is the provision of a compact folding form which makes the hanger especially convenient for travelers.

DARK ROOM LAMP.—J. P. HANSEN, 10 Jacoby Allé, Copenhagen, Denmark. The invention relates to a lamp for photographic use. Among the features are that the light rays are obliged to pass colored glasses before they pass the reflector, the lamp giving an indirect light which can be easily adjusted from one color to another, or mixed at will. The lamp may also be used for the printing of bromide paper, and for the retouching of negatives.

BED.—J. S. BAILEY, care Honolulu Auction Rooms, Honolulu, Territory of Hawaii. This invention has for its object to provide a construction of vertical filler rods, and a manner of connecting the same to the upper and lower hori-

A SECTIONAL VIEW SHOWING A FILLER ROD IN CONNECTING POSITION

zontal rods of the head and foot members or side members of beds, cribs and the like, which will sustain all strains without danger of collapse. The filler rods have curved lugs at their ends, the lug at one end projecting in a direction opposite to the lug at the other end.

TOOTHBRUSH.—L. KARAS, 179 W. 89th St., New York, N. Y. The object is to provide a device of this nature in which that portion of the head containing the bristles is entirely removable so as to be renewable and thus save a great amount of expense in the purchase of new brushes, in that one handle may be used indefinitely and any number of new brush parts secured thereto. The bristles may be cleaned far more easily than those employed with the usual toothbrush.

SMOKING PIPE.—K. B. ABERNATHY, Medicine Hat, Alberta, Canada. The general object of the invention is to provide a smoking pipe with a more nearly perfect combustion to thereby consume the poisonous matter in the tobacco, to prevent the formation of deleterious and objectionable deposits which in the ordinary pipe are formed in the bowl and stem, and to provide a construction whereby a thorough cleaning of the pipe is facilitated.

INDIVIDUAL SEPTIC TANK.—H. BYRD, University, Miss. The invention relates generally to septic tanks and more particularly to a simple construction adapted for family use, and designed especially for use in connection with porous soil or rock formation, but which may be adapted to any formation, means being provided to recurrently operate to discharge only the fluid above the sediment and normally sealed by the contents of the tank.

CONVERTIBLE SWING.—E. B. BLACK, Commerce, Ga. The invention has for its object to provide a swing which may be easily converted into a hammock or reclining swing. The essential feature of the invention is a detachable plate, being connected at one end to the cushion and hinging the cushion to the seat frame so that when the strip is extended it will form a hammock. The device may be constructed of any desired material.

GATE.—H. C. HAINES, Geneseo, Ill. The purpose of the invention is the provision of a gate latch which allows the operating of the gate only when the gate is raised above the normal height, and the latch actuated while in its elevated position whereby the opening of a gate by an animal is prevented. A lever is provided for the latch which when in active position serves as a support for the gate to prevent sagging.

CUFF LINK.—R. A. GILL, Box 640, Berlin, N. H. The object of the invention is to provide a link especially adapted for connecting link cuffs with the ends inclining toward each other instead of lapped in such a manner that they will be held in such inclined position without bending of the cuff or danger of breaking the same when stiff cuffs are used.

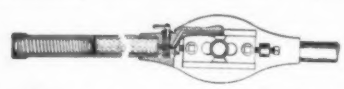
METAL MOLD AND PROCESS OF MAKING THE SAME.—J. D. MCNEILL, 9850 Charles St., Chicago, Ill. An object of this invention is to provide a metal mold from which a large number of castings can be made, thereby obviating the necessity of making a separate mold, as in sand molds. A further object is to provide a metal mold whereby the work of casting certain articles may be materially lessened, thereby tending to greater economy.

FIRE BALLOON FOR SEARCHLIGHT PRACTICE AND FOR OTHER PURPOSES.—J. U. COATES, Exeter, England. The object of this invention is to provide a simple and efficient balloon provided with a heating device comprising a reservoir containing methylated spirit or other suitable liquid hydrocarbon or fuel, and provided with fine apertures through which the vapor of such fuel may issue to be burned as it emerges, and a burner external to, but in association with, the reservoir for the purpose of vaporizing the hydrocarbon.

SHOE LACE HOLDER.—A. G. HALL, 10 Hartwell St., New Brunswick, N. J. The particular object of the invention is to provide a shoelace holder adapted to engage the bow of the shoe lace, which will be very inconspicuous and present a neat appearance and will retain the lace so that it will be practically impossible for the bow to come untied.

Hardware and Tools

PIPE CUTTING DIE.—E. DE TEIXEIRA, East Setauket, L. I., N. Y. Among the principal objects which the invention has in view are to automatically oil an article during the process



A SIDE VIEW OF CUTTING DIE, HAVING HANDLE WITH LUBRICATED RESERVOIR

of having a screw thread cut therein, to provide a supply lubricant carried by the metal cutting instrument, and to prevent the flow of the lubricant during the inactive periods of the cutter.

GRATING.—H. H. URIS, 515 W. 26th St., New York, N. Y. The invention is more particularly intended for embodiment in street and area gratings and especially gratings of the type employing cross bars or other elements the equivalent of checker work or the like to prevent baby carriage wheels and other articles from dropping between the longitudinal bars of the grating.

SELF-SEATING DOOR HANDLE.—G. W. KENNINGTON, 414-16 3rd Ave., Brooklyn, N. Y. The invention is particularly adapted for use in connection with sidewalk, trap, or other doors which are usually arranged in a substantially horizontal position. Among the objects is to provide a handle which is simple in construction, inexpensive to manufacture and which is self-seating, forming a substantially water-tight joint and laying substantially flush with the top of the door when not in use.

MIXING VALVE OR FAUCET.—J. L. T. POPP, 630 22nd St., Niagara Falls, N. Y. The invention relates to valves or faucets used on bath tubs, basins, sinks and similar fixtures. Its object is to provide a mixing valve or faucet connected with a hot and cold water supply and arranged to permit the user to draw either hot water or cold water or a mixture of the same. Another object is to permit of setting the mixing valve for mixing hot and cold water to any desired degree. The device is simple and not liable easily to get out of order.

Machines and Mechanical Devices

TENONING AND EQUALIZING MACHINE.—W. F. MCCARTY, Defiance Machine Works, Defiance, Ohio. The object of the invention is to provide a machine more especially designed for accurately tenoning and equalizing sticks of wood or wooden spokes for the wheels of vehicles. Another object is to cut off both ends of spoke simultaneously, and to provide one end of a spoke with a tenon for engagement with a socket in a felly of a wheel. A further object is to dispense with high skilled labor in running the machine.

FILTER.—L. WACHENBERG, Reserve Sugar Refinery, Godchaux Sugar Inc., Reserve, La. Among the objects of the invention is to provide a construction of a compact nature but having large capacity for the output therethrough, but which being relatively small and being equipped with special means for manipulation provides for the cleansing, renewal or interchange of the filtering elements with convenience, but provides ample room to accommodate a considerably large number of filter press units.

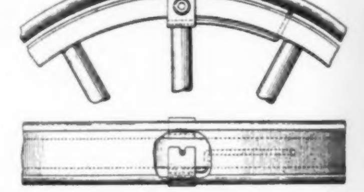
LUG-STRAP CONNECTION.—L. DURAND, 128 Oxford St., Brooklyn, N. Y. This invention relates to picking mechanisms for looms, its object is to provide a lug-strap connection arranged to reinforce the picker stick with a view of preventing the picker stick from breaking when the loom is running. Other objects are to dispense with the usual loop for stirrup straps, and to permit of applying the lug-strap connection to picker sticks of usual construction without requiring alteration thereof.

WELL BUCKET.—C. D. BEHAN, Stigler, Okla. The object of the invention is to provide a bucket especially adapted for use in bored wells, or other wells having a restricted bore, wherein the bucket is normally open at the bottom and is provided with a check valve at its top normally closed and capable of being opened manually to permit the contents of the bucket to flow out.

MACHINE FOR TRIMMING RUBBER HOSE.—F. C. MOORE, Canton, Ohio. An object of the invention is to provide a device by means of which the excess rubber which is forced out between the edges of the vulcanizing press in the final operation of vulcanizing the rubber portions of hose may be economically removed so as to give the hose a proper finished appearance. A further object is to provide a device by which the excess portions on each of the base may be removed simultaneously.

Pertaining to Vehicles

DETACHABLE RIM FASTENER.—H. J. PRESTON, c/o Lincoln & Clay Co., Santa Clara, Cal. This invention particularly relates to fastening lugs for wheel rims. An object is to provide a fastening means involving a lug and appurtenances thereto, the use of which will accurately center the rim and positively prevent creeping. This object is attained by



A SIDE ELEVATION AND PLAN VIEW PARTLY BROKEN AWAY

providing a lug which, in addition to its primary fastening function, is provided with a secondary fastening means to secure the detachable rim at a point distant, thereby providing with each lug two points of engagement with the rim and positively locking the rim against movement.

Designs

DESIGN FOR A MOCCASIN.—L. CHABERT, Lewiston, Me.

DESIGN FOR A PIN.—L. D. HACKETT, address A. D. Penney, Townley Bldg., Miami, Florida.

DESIGN FOR A GAME.—J. HARO, 525 W. 123rd St., Apt. 6, New York, N. Y.

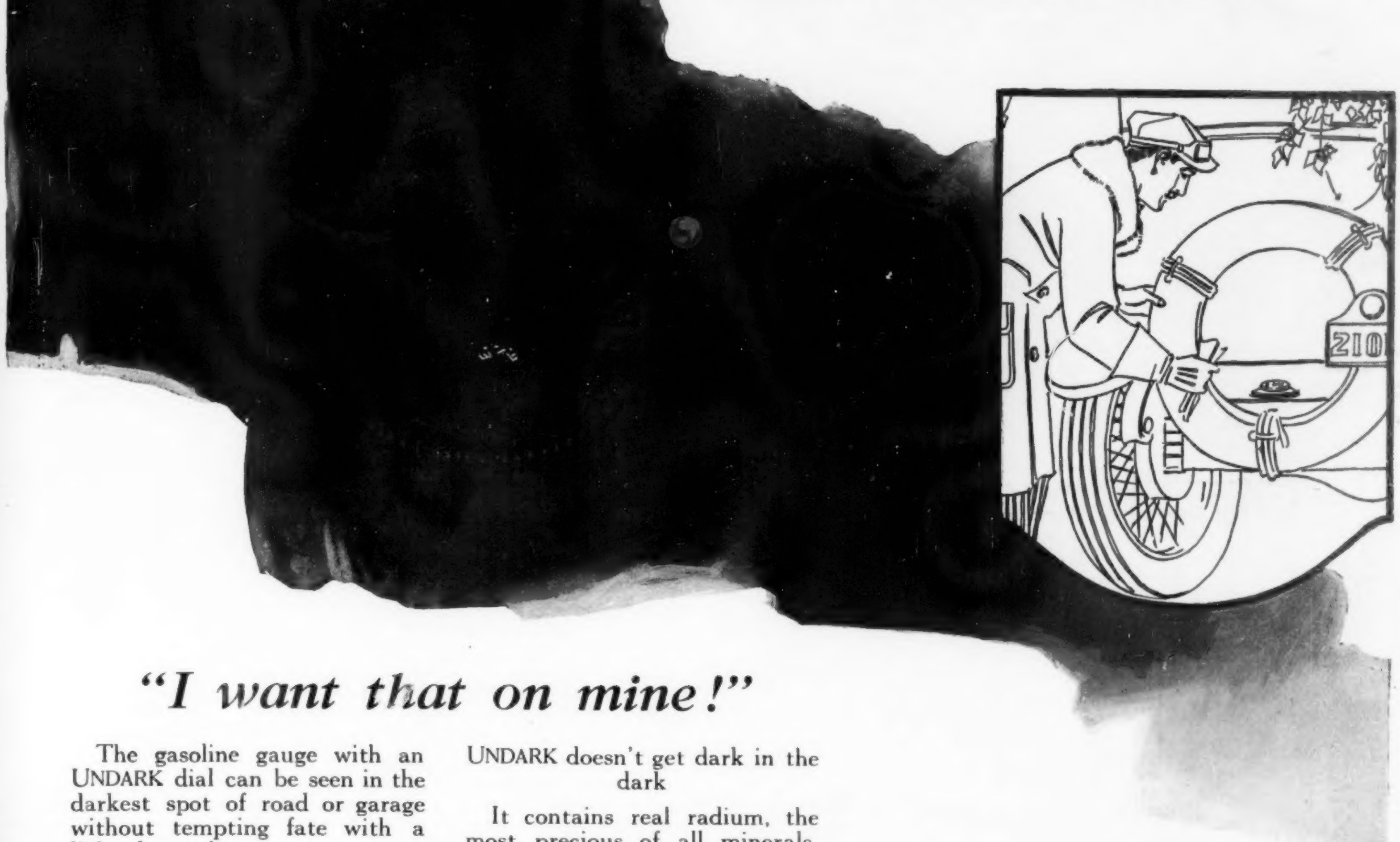
DESIGN FOR A STATUETTE.—F. A. KOCH, 269 E. 194th St., New York, N. Y.

DESIGN FOR A TOY.—MILDRED E. SHUGG, 1462 Pacific St., Brooklyn, N. Y.

DESIGN FOR A POWDER CONTAINER OR SIMILAR RECEPTACLE.—C. S. HUMPHREY, c/o Manhattan Can Co., Bush Terminal Bldg., No. 10, Brooklyn, N. Y. This invention has been granted three patents on ornamental designs of a similar nature.

UNDARK

Radium Luminous Material



"I want that on mine!"

The gasoline gauge with an UNDARK dial can be seen in the darkest spot of road or garage without tempting fate with a lighted match.

The same 24-hour service is also extended to watches, clocks, compasses, by the use of UNDARK on dials and hands. It makes electric buttons and pull-chain pendants visible in the dark; it's a convenience on locks, door knobs, house numbers, etc., and on pistol sights for straight shooting in an emergency at night.

UNDARK doesn't get dark in the dark

It contains real radium, the most precious of all minerals. UNDARK keeps glowing for years.

The leading manufacturers in many different lines are adding to the usefulness of their goods by using UNDARK.

We are miners and refiners of radium-bearing ore, the pioneer manufacturers of radium luminous material in this country and the largest in the world.

UNDARK can be successfully applied by manufacturers in their own plants. It is a simple process. We will instruct operators and organize the work for you. Write for details.

Radium Luminous Material Corporation

58 Pine Street, New York City

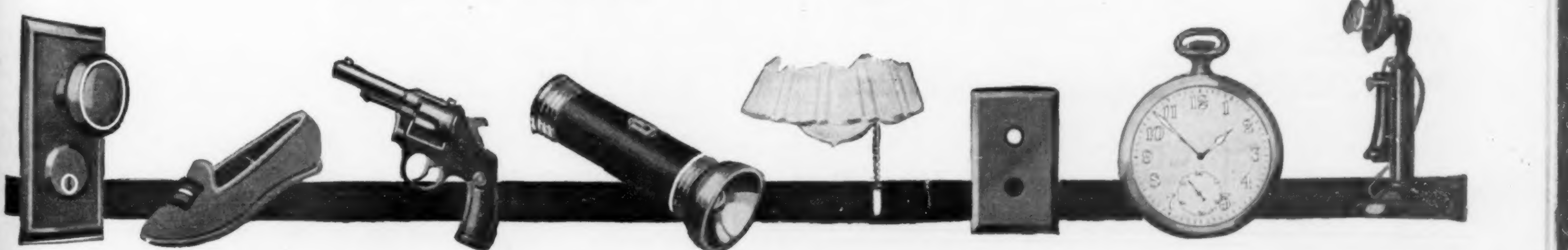
Factories: Orange, N. J. Mines: Colorado and Utah

Trade Mark Name UNDARK Reg. Applied for

UNDARK is used on numerous articles, of which the following are the most important

Watches	Gasoline Gauges
Clocks	Speedometers
Flashlights	Steam and Pressure Gauges
Pull-Chain Pendants	Revolver Sights
Push-Button Switches	Telephone Mouthpiece
Flip Switches	Fire Extinguishers
Door Bells	Mine Signs
House Numbers	Women's Felt Slippers
Hospital Call Bells	Fish Bait
Ship's Compasses	Theatre Seat Numbers
Locks	Convention Buttons
Safe Combinations	Poison Indicators

Names of the makers of these furnished upon request



Where the Petroleum Goes

(Continued from page 3)

ture should, for the American bulk production, remain practically unaltered. If, then, we find that from one year to the next we are getting out of our petroleum more of one thing and less of another, this can be fairly attributed to changed methods of treatment. Let us examine the figures for what they reveal in this direction.

The Government reports give the amount of oil fed into the distilleries in units of barrels; they give the liquid products recovered in terms of gallons; and finally they show the solid residues—wax, coke and asphalt—in tons. We cannot compare these various items on any basis of weight, for the weight per unit of bulk is the very thing that changes when we start to recover more of, say, the gasoline and less of something else. The only way in which we can attempt a percentage comparison will be on the basis of bulk; and this is perfectly fair, since any shifting of heavier fractions into lighter classifications will show up in this way.

In 1917 our refineries handled 14,487 million gallons of crude oils; in 1918, 15,817 million gallons; and in 1919, 17,096 million gallons. From this we got in 1917 2,851 million gallons of gasoline; in 1918 3,571 million gallons; in 1919 3,958 million gallons. For 1917 the gasoline recovered was 19.7 per cent of the crudes treated; for 1918 it was 22.6 per cent; and in 1919 23.2 per cent. This indicates that the definition of gasoline has been extended and the product debased by the inclusion of fractions that were formerly classified with the kerosene. You cannot increase the gasoline content of a given aggregate of petroleum by nearly 18 per cent unless you thus admit as gasoline something which was not previously admitted. If the 1917 definition of gasoline were to be enforced today, we should have had but 3,367 million gallons of "petrol" for 1919; the shortage would have been worse and the price higher, but as a partial offset the quality would have been better.

If we investigate the kerosene fraction to see what its loss was, we find what may at first be a surprise. The only place from which we can borrow near-gasoline is the kerosene fractions; yet in the face of this fact and of the evidence that we did so borrow, the kerosene recovery was 11.9 per cent (1,727 million gallons) for 1917, 11.5 per cent (1,825 million gallons) for 1918, and no less than 13.5 per cent (2,342 million gallons) for 1919. The answer, of course, is simple; we borrowed from Peter to pay Paul—or dropping figures of speech, what the kerosene fractions lost at the top to the gasoline, they got back with interest at the bottom from the fuel-oil group. Kerosene as well as gasoline has had to be debased to keep up with the procession.

The gas-oil and fuel-oil fractions that comprise the next group represent the biggest single item in oil refining. For 1917 45 per cent of the crudes went in this direction (6,513 million gallons); for 1918 46.3 per cent (7,321 million gallons); and for 1919 44.6 per cent (7,627 million gallons).

The very essential lubricating oil comes next in the scale. This accounted in 1917 for 5.2 per cent of the crude oil refined (754 million gallons); for 5.3 per cent (841 million gallons) in 1918; and for an even 5 per cent (847 million gallons) in 1919. So here, too, we fail to find a shrinkage which would indicate an end of the borrowing process; the lubricating oil supply must have been stretched by falling back upon some of the still heavier components, which had previously been allowed to remain in the solid residue of the refining process.

The Government statisticians recognize, in addition to the four major groups covered so far, a classification of miscellaneous character. We may get some idea of what this covers by examining the detailed analysis furnished for 1919, showing its make-up to the last detail, even to 105 gallons of "ink oil." We find listed here such items as binder, flux, petrolatum, road oil, sludge, distillate, medicinal oils, etc., etc. This miscellaneous caption in 1917 accounted for 4.9 per cent (703 million gallons) of the crude oil treated; in 1918 for 8.1 per cent (1,287 million gallons); and in 1919 for 7.5 per cent (1,279 million gallons). Finally, we are told that refinery losses from evaporation and other causes are held accountable for 549 million gallons of material in 1917, representing 3.8 per cent of the total; and for 611 million gallons in 1918 and 672 million gallons in 1919, in each case 3.9 per cent of the supply of crude oil.

The three solid residues of wax, coke and asphalt are listed in tons, and without data as to their specific gravity it is of course not possible to put them on a gallon basis. They represent, however, whatever of the crude oil has not otherwise been accounted for. On this basis, the 1,519 thousand tons of wax, coke and asphalt produced by the refineries in 1917 must be taken as accounting for 9.5 per cent by bulk of the petroleum treated; while the 1,420 thousand tons of 1918 and the 1,739 thousand tons of 1919 in each instance represent but 2.3 per cent of that bulk. This puts us on the ultimate trail of the borrowings made from Peter for the benefit of Paul. If a greater tonnage of solids in 1919 than in 1917 represents barely one-quarter as high a percentage of the bulk of raw material, we have a verification for the very natural assumption that as we pass upward in the scale of specific gravity, robbing each series of its lighter elements to enrich the preceding series, the final and heaviest series must finally have to pay the bill—there is nowhere for it to turn for replenishment. The figures indicate very clearly that this progressive transfer from heavier to lighter classifications all along the line is precisely what has happened, precisely the manner in which the supply of petroleum products has been stretched so close to sufficiency as has been the case. The various petroleum distillates have been promoted; parts of the old kerosene fraction have been admitted to the gasoline group, the kerosene supply has been recruited from the fuel oils, these in turn from the lubricants, and finally the latter have been forced to admit constituents that were formerly allowed to remain behind as solids.

The variable character of petroleum is further demonstrated by the peculiar showing of the solids, in the classification by sections of the country for 1919. The Atlantic Coast refineries get close to 11 pounds of asphalt out of every barrel of oil treated; the Oklahoma-Kansas and the Colorado-Wyoming fields together extracted but 192 tons of asphalt from 88,000,000 barrels of crudes. The Indiana-Illinois field produced petroleum running 8 pounds of coke to the barrel, while there was not a pound of coke recovered from the California oils, which, however, were richer than the average in asphalt. Finally, as against 4 pounds of wax to the barrel of Pennsylvania crudes, the petroleum from the California field shows less than half an ounce of wax per barrel. For the United States as a whole, the petroleum shows 1.1 pounds wax, 2.98 pounds coke, and 4.4 pounds asphalt per barrel of oil. The oil-barrel, by the way, contains 42 gallons.

It will be of interest and importance to watch statistics for future years and see just how far and how fast we go in the process of pushing our motor fuel down the scale from gasoline to kerosene. Some of us, when we try to start our cars on a regular winter day, are prepared to believe that we have already gone most of the way; but future performance will probably show how hasty this supposition would be.

Romance of Invention—XIV

(*Continued from page 8*)

University of California, anywhere from the Department of Botany to the Department of Physiology: "Oh, go tell Cot about it. He won't know anything about your subject, but you won't talk to him ten minutes before he'll give you an idea.'" And this seems entirely characteristic. His own work he credits largely to those who have worked with him, but it remains for others to refer to him as a catalyzer of men. Catalytic processes, it will be recalled, are those in which some agent produces results while remaining itself unchanged. And Cottrell seems to have that type of mind, which inspires in others new thoughts, new ideas, often new ideals, without such inspiration taking anything from his own brain. Thus, the demulsification of the California oil well water was solved by a suggestion of Cottrell's, a thing for which he takes no credit, yet which is surely his, since he but applied to the problem the same methods and the same reasoning which solved the electrical precipitation problem of solid matter from gases.

The first installation of the Cottrell process in commercial work was at the Hercules Powder Plant at Pinola, California, where there was a small sulfuric acid plant. A twenty thousand volt current was used, the insulated high potential electrode being covered with pubescent (hairy) asbestos. It was successful but the plant was too small for it to operate at a profit. Nearby, however, was the Selby Smelter, a large plant near a tunnel of the Southern Pacific Railroad, which tunnel was frequently fouled with the sulfur trioxide fumes from the silver dissolving house. Legal proceedings by the railroad threatened to stop the operation of the smelter. Then came Cottrell to the rescue with a small electric plant which is running today, and the harmful fumes were caught and metamorphosed into useful dilute sulfuric acid, which became a by-product of the smelter. The tunnel was cleared, legal proceedings were stopped and the Cottrell process was on the map. Fume-pestered farmers all over the West who had sued smelters right and left succeeded, with the Selby plant example before them, in convincing judges and juries of the fact, that they were not asking the impossible of the smelters when they demanded suppression of the fume nuisance, but only asking for needed relief which could be readily obtained.

As the fume problems of the various industries differ so widely, it is obvious that special apparatus and special arrangements must be made to cope with each. But there have been none which the engineers of the Research Corporation have not been able to solve. By having the patents in the hands of engineers whose desire is to get the process working, to get it in the hands of those who can use it, and who are asked to pay, not a huge personal profit, but merely a nominal license profit, which is turned into the corporation for further scientific work, there is eliminated all the matter of money-making expediency which so frequently retards, rather than develops, an invention. The Research Corporation is paying its way, is spending more a month than it originally had capital for a start, is employing a large staff to do its work and has established a Fellowship in Applied Science, awarded yearly, to stimulate scientists, inventors and discoverers to further research and assist them in such labors.

Dr. Cottrell prefers to work where he is of the most use rather than where he will make the most money. He seems to prefer to spend his life (he is forty-three years old) catalyzing other men into mental activity, making new discoveries himself, furthering the comfort and convenience of the world at large than in developing a big income for himself.

But if he builds no monument of wealth to his name, he has done that which is of infinitely greater worth. To a world just learning how unnecessary any waste may be he has given a very potent means of saving waste, and devoting the profits of his wonderful discovery to the increase and wider diffusion of valuable knowledge among all men. More power to him, and may there be others like him in the days to come.

Baltimore's Tilting Dam

(*Continued from page 12*)

friction due to corrosion, etc., at the pin tends to increase the head required.

It should, of course, be understood that the diagrammatic section is much simpler than the real thing, composed as the latter is of timber and metal parts. The slanting upstream face which restrains the water for a time is a wooden diaphragm bolted to a metal frame. In one type of unit there are two triangular frames of angles and plates. These are set 8 feet apart, center to center. On the upstream edges of the frames are bolted three I-beams which serve a purpose similar to that of joists. The wooden decking is bolted to them after the manner of flooring. However, this decking presents a surface 12 feet long, measured parallel to the dam, and a little over half as broad, measured from toe to crest. Anchor blocks of metal were installed for the purpose of providing a means of pivoting or hinging the unit dams to the top of the masonry construction. As the crest was provided with keyways which are to be used when in the future the dam is enlarged in thickness and height, the center one was utilized as a suitable depression in which to secure the anchor blocks. When a block is in place the axis of the pivot hole is 2 inches above the masonry crest.

The manner of fixing the anchor blocks securely in place is of interest. An anchor block consists of three separate castings. The principal one has the pivot hole. It was readily set in place in the rectangular groove in the top of the masonry. The remaining two pieces were then slid in to approximate position. Each of these pieces had a toothed surface to present to the vertical wall of the groove. One was located on the upstream and the other on the downstream end of the main block. By means of wedges, these two pieces could be made to extend the body of the main block so as to fill the masonry groove from one vertical face to the other. If, now, their positions could be rigidly maintained, the block should be held very firmly indeed against any overturning action exerted through the pivot. In order to meet this requirement, space underneath the casting was left when setting it and this was later on filled with a grout made of cement and sand (1:2); and the interstices between the small castings and the big one were filled in with lead.

The frames of some, at least, of the units were so dimensioned and shaped that upon tilting the foot D rests in the next keyway downstream. At this juncture, the wooden face, while tolerably flat, has not yet reached a full horizontal position. This means that some amount of face is still presented to the oncoming water. However, after making all deductions for this face and part of the framework, there is a clear opening, for this type, nearly 15 inches high. Here the water flows over the masonry crest and beneath the wooden face.

A question that may now be put is this: Will the dam, after it has once tilted, reverse itself upon subsidence of the water? Usually, the dam reverses, it is said, when the water falls to elevation 188.75 feet or a little less. This would seem to mean that when the depth of water on the masonry crest gets down to 9 inches or something less, the center of gravity has moved over to a position a trifle upstream from the pivot.

Five Men Around the Table

Automobile History in the Making

Henry M. Leland, Wilfred C. Leland and some of their Associates in the Lincoln Motor Company

AROUND a table in a modest office some eighteen years ago, five serious-minded men sat in consultation. They had sat in consultation many times before. For a number of years these same men had worked and thought and studied and planned together, always with the same objective—to do things better and to make things better than they had ever been done or made before—in fine machinery, fine tools, and internal combustion engines.

A conference of 1902 which marked the sunrise of America's motor car industry.

"Yes, boys, that's good, but it isn't quite good enough." It was the eldest of the group who spoke. "This piston fits perfectly into this particular cylinder," he said, "but we must make every piston so exact, and every cylinder so exact, that every piston will fit perfectly into every cylinder. Then, if anything happens to either, it can be replaced by another; and the car owner will not be obliged to buy both cylinder and piston if only one should be injured.

"And this wrist pin," he continued, "must be made accurate to the half-thousandth of an inch. Its bearing must be made with the same precision. Then there will be a perfect fit, and practically no wear-out to it. Otherwise, the slightest 'play' means early wear, and destruction."

And on, and on, and on, the conference continued for hours, and was resumed day after day—until the last bolt and nut had passed scrutiny.

Earnest and thoughtful, tho these men were, little did they dream of the far-reaching influence of that council upon what was to become one of the world's greatest industries, an industry which has now become one of the great factors in civilization.

The leaders of that history-making conference in 1902 were Henry M. Leland and Wilfred C. Leland.

They were discussing and passing judgment upon an automobile design, upon specifications and materials; and determining upon the accuracy to be followed in making the various parts— accuracy expressed in thousandths of an inch, and even in fractions of a thousandth.

Three cars were completed, and subjected to most rigorous treatment. Materials were ordered to build three thousand of them. These were eagerly absorbed and more than twenty thousand were distributed within the next five years.

It is strikingly significant that many of these original Leland-built cars are still in service; and many of the engines after eighteen years are doing duty in stationary power work—in the small shop, and on the farm.

It was this Leland-built car which brought honors to America when it was awarded the Dewar Trophy—a tribute bestowed annually by the Automobile Club of Great Britain in recognition of the greatest advance in automobile development.

The same five men in 1920, in a conference which presaged new and better things in motor cars

From a number of cars in stock, the Club's technical committee selected three. These cars were entirely disassembled, down to the very last piece. The parts were then mixed promiscuously. Eighty-nine parts were withdrawn and replaced by like parts from service stock.

Mechanics then assembled three "new" cars with parts taken at random, there being nothing to identify their original assembly. Not so much as file or emery cloth was used, or needed; yet every part fitted as perfectly as in the car from which it was taken.

In many instances, inaccuracy of the thousandth part of an inch—even inaccuracy so fine as a third of the thickness of a hair from your head—would have meant failure. But the test was an unqualified success.

The profound impression made upon the manufacturing world by that remarkable achievement, thousands will still recall.

It immediately compelled recognition of the Lelands as foremost exponents of precise workmanship and true standardization—a recognition more complete today than then.

A few years later, another Leland-built car was awarded the Dewar Trophy. This time it was the result of the eminently successful test of the then new electrical system of automatic cranking—lighting—ignition.

Leland-built cars were the only American product ever to receive that much coveted tribute, and the only make of car thus honored twice.

In 1914, twelve years after the conference first here pictured, there was another series of consultations. These men were now developing, modifying and refining the V-type eight cylindered engine with which the Lelands were once more about to revolutionize the trend of fine car making.

January 7, 1920, five men were again in conference. They were the identical five men who were around a table eighteen years before. They had been in continual relation for more than twenty years, always with the same objective—to do and to make things better—to build motor cars better than they had been built before—cars of greater comfort, greater convenience and greater utility.

They are men who have inaugurated many epoch-making periods in the more important motor car developments.

In the conference of January last, the same five men, with scores of earnest, loyal associates, were preparing to inaugurate another epoch-making period; this time the new Leland-built car—a car such as thinking men and men who know the Lelands would naturally expect.

It is a car not only the outgrowth of eighteen years' experience and devotion to fine car making, but a car expressing, more truly than ever before, Leland foresight, Leland courage, Leland initiative, and Leland determination to achieve—and to surpass.

LINCOLN MOTOR COMPANY DETROIT, MICH.

How Plate Glass Is Made

(*Continued from page 14*)

gage the production of plate of any desired thickness. The semi-fluid glass is now poured from the pot on to the table, and a huge roller passes over it, ironing it out into a layer of uniform thickness. This might seem to be the end of the matter, but there is still a lot to worry about before that sheet of glass is ready for the market.

In the first place, while now substantially solid, it is still far from cool; and if allowed to cool without special treatment, it would crack, curl, shrivel, and do all sorts of unpleasant things. So it goes to an annealing oven, where its temperature is brought down by slow and easy stages, in such a way that no damage to the plate results. On leaving the ovens, it doesn't look much like the beautiful smooth sheets of plate glass which we see in the store windows. Its surface is rough, opaque, altogether unprepossessing—but only the surface, for inside it is clear as crystal. So it goes to the cutter who takes off the rough edges and squares it to the proper dimensions; and from his hands it passes to the grinding room.

The grinding table is a big revolving platform of iron. It is prepared for action by being flooded with plaster of paris and water; then the slab of glass is lowered upon it with the utmost care, men climb on top of it, and tramp it into place until it sinks well into the plaster and the latter sets about it. Still greater security is got by pegging with wooden blocks; then the table is at length set in motion. The grinding is done by revolving runners. Sharp sand is fed on to the glass, and a stream of water constantly flows over it. After the first cut by the sand, emery is substituted, and then finer emery, and finer still. At the conclusion of the grinding process the plate is carefully inspected. Nicks, fractures and flaws are found, and the plate is squared upon again in smaller size or sizes to eliminate these, or if they are too serious to permit this, it is fed back into the pots as cullet, or broken glass, of which a certain proportion goes into each charge. The parts that get past this inspection are polished much after the same style that regulated the grinding operation, the only difference being in the abrasives, which are here of course much finer. Rouge (iron peroxide) is the standard here, and it is worked over the glass with felt runners, so arranged that every part of the glass passes under every part of the runners, tending to compensate for any slight irregularities.

Altogether the grinding and polishing reduce the plate to about one-half its original thickness, or even less. The material washed away represents a permanent loss, since it is so commingled with the abrasive particles that it would not be profitable to attempt its recovery. New plate glass is a delicate sea-green, when viewed through the edge. When exposed for a period to sunlight this fades slowly to a yellow or light brown, which makes it difficult to match new glass in with old.

When the plates are to be bevelled, a good many additional processes are necessary. The roughing mill or roughing wheel is a circular cast-iron disk having a fine-cut corrugated surface about thirty inches in diameter. This revolves rapidly, while sand or carborundum is conveyed to it from above through a hopper with a stream of water, the sand giving the desired roughness between the iron and the glass while the water minimizes the frictional heat. The edge of the glass is brought into contact with the swiftly moving roughing wheel, which revolves in a horizontal plane, and the sand cuts the bevel to the desired depth. Curves and patterns with incurves, miters, etc., require great skill on the part of the operator. Then a second roughing process follows in a second mill, with a finer abrasive, designed to smooth out some of the troughs left by the first cut. After this a mill of fine sandstone, with no intermediary save water, is employed for what is known as the smoothing out. The polishing wheel brings the surface of the bevel to a dull, milky finish by means of powdered pumice. Then comes the final high-gloss polish, effected with rouge and a layer of heavy felt.

The edge of the glass, according to the use which it is intended to make of the plate, is rough ground, squared, or chamfered as desired, and often is polished much as is the bevel. Ornamental lines are frequently cut about the edge, etc., and this is done with a very sharp-edged wheel in the first instance, followed by polishing operations.

Orchard Medicine Quacks

OUR idea of a genuinely discouraging farm experience is that of a Pennsylvania orchardis who, in a conscientious effort to control pests, used the wrong spray material and killed 22,000 trees. This orchard tragedy stands out be cause it is exceptional as to size, but it could be matched as to essence by thousands of other authentic instances. Like drinking medicine in the dark out of a bottle labelled with cross-bones, is the use of the wrongly picked or wrongly applied fruit spray. Because the appearance of dangerous orchard pests, reaching now to practically every section and locality, makes spraying absolutely necessary, the danger in the situation, unless care is taken, bulks large.

And a deplorable, and widespread fact, is that most such orchard tragedies happen to progressive, enterprising fruitgrowers, men who oftentimes are experts in their line. It was thus with the orchardist who lost 22,000 trees. The error in most cases comes in following advice—for this new department of fruitgrowing is one on which the average grower must seek information—given by irresponsible, unreliable people, the quacks of the "tree medicine" business. In a financial way, a vicious patent medicine can play about as much mischief in the farmers' business as it can anywhere.

Ultimately authorities will see to it that farmers are adequately protected against quacks and frauds, but until this day is fully here, the safe thing is to go straight to the state college or experiment station fo radvice on a ticklish subject, and then adhere strictly to the directions given.—By *J. T. Bartlett.*

Moisture Absorption Through Varnish

IN experiments made by the Forest Products Laboratory, it was found that varnishes do not entirely prevent the transmission of moisture into wood but merely retard it, and that apparently there is no difference in moisture absorption through the coating due to the species of wood used.

The panels used in the experiments were of yellow birch, basswood, red gum, African mahogany, white ash, white pine, Sitka spruce, southern yellow pine, bald cypress, incense cedar, white oak, western yellow pine, Port Orford cedar, and sugar pine.

Three coats of high-grade spar varnish were applied to 4 panels of each species. Two panels of each species were brush-coated and two were dipped by a special dipping machine designed to secure an even coating. The panels were allowed to dry 72 hours between coats and 10 days after the final coat before they were given the moisture-resistance test.

The moisture-resistance test consisted in exposing the panels for 17 days to a humidity of 95/100 per cent, or in an atmosphere practically saturated with moisture.

At the end of this test, it was found that all the brush-coated panels had absorbed between 5 and 6.5 grams of moisture per square foot of surface, and the dipped panels between 4 and 5 grams.

The Naturalist's Corner

Botanical Notes from All Quarters of the Globe

By H. A. Gleason, Ph. D.

A Newly Introduced Weed.—The Japan honeysuckle, which has begun to run wild in the eastern and southern states in the past two or three decades, is an interesting example of a woody-stemmed weed, according to E. F. Andrews in *Torreya*. Formerly seen only in cultivation, it is now firmly established in woodlands and along stream borders in many localities, where it makes an almost impenetrable jungle with its tangled climbing stems and frequently smothers completely the plants which it covers. It trails on the ground when a support is not available, and it is suggested that in this habit it may have some economic value in preventing or reducing soil erosion.

Blueberries in Cultivation.—A tall species of blueberry which grows wild in the swamps of northern Florida has recently been introduced into cultivation through the efforts of Mr. M. A. Sapp of Pensacola, Florida. About 20 years ago Mr. Sapp selected 100 wild plants that were producing unusually good fruits and transplanted them to a cultivated and well-drained field. The plants thrived and fruited more abundantly than when growing in the natural habitat, and the fruit found a ready market at once. The plantation was enlarged until it now covers over eight acres. The annual yield is about 3,200 quarts per acre and the entire crop finds a ready sale at 10 to 12½ cents a quart. Several rather distinct types of plant in respect to habit of growth have been found and there is considerable variation in the quantity and quality of fruit produced by individual plants which gives opportunity for improvement by selection. The most desirable type for commercial culture is one that grows to a height of about eight feet and has a compact and freely branching habit of growth with fruit well distributed over the branches. The berries range from 10 to 14 mm. in diameter. The quality of the fruit is quite like that of the northern blueberry, which has also recently been domesticated and greatly improved.

Vinifera Grapes in the Eastern States.—Through recent experiences with vinifera grapes in California, horticulturists have learned that the failures of the early attempts to cultivate this grape in the East were due chiefly to the attacks of fungi, such as powdery mildew, downy mildew, and black rot, the serious injuries of a parasitic root-sucking louse called the *phylloxera*, and winter injury. It is now known that all these destructive agencies can be controlled. Actual demonstration of this has now been made at the Geneva Experiment Station, where for the past six years varieties of vinifera grapes have fruited satisfactorily. A report has already been published describing cultural requirements and methods of propagation, and giving a list of the most desirable varieties of table and wine grapes suitable for culture in New York State. Compared with the fruit of our native varieties these of vinifera are more solid, the skin adheres to the flesh, there is a higher sugar content, the flavor is richer, and the fruit keeps longer in storage. It appears certain that viticulture in the eastern United States is to be extended and greatly enriched in the future through the successful cultivation of pure and of hybrid strains of the European grape, the culture of which in the Mediterannean region dates from prehistoric time.

Fictitious Botanists.—Science deals with facts, but some supposed scientists are only a fiction! At least so Dr. J. H. Barnhart reports in a recent article in the Journal of the New York Botanical Garden. He finds that a well-known cyclopedia lists a number of such imaginary persons and discusses fourteen of them in detail. They are all described as Europeans, mostly of the eighteenth and early nineteenth centuries, who traveled extensively in what were then little-known regions of the two Americas, collected diligently, made important observations, and then returned to Europe to publish their discoveries in thick volumes with resounding titles. Dr. Barnhart infers that the same cyclopedia may contain other names equally fictitious.

Origin of the Loganberry.—It now appears that the plant that has recently become well known as the loganberry is a red-fruited variety of a trailing blackberry that grows wild on the Pacific coast, rather than a hybrid between this blackberry and a raspberry. Such is the view given by George M. Darrow in a recent Farmer's Bulletin from the Department of Agriculture. Mr. Darrow calls the plant the "Logan blackberry," in reality therefore a red-fruited blackberry. It is reported that this variety is distinguishable from certain black-fruited varieties only by the character (chiefly the color) of the fruit, and that there are also wild forms of the species which have red fruits. It is clear, however, that the original seedling of the Logan blackberry was grown from a seed taken from a black-fruited plant that grew in Judge Logan's garden. The Logan blackberry is found to be adapted to culture in the milder parts of the Pacific coast states. The variety does not thrive in any of the central or eastern states and thus far no strains adapted for culture in these states have been developed. Several forms of blackberries and blackberry-raspberry hybrids that closely resemble the Logan blackberry are also described.

Is It Necessary to Fertilize an Apple Orchard?—The answer to this question is being sought in the results of a carefully conducted experiment at the State Agricultural Experiment Station at Geneva, New York. The experiment has already been in progress twenty years, and the results to date have recently been reported in a bulletin from that station. Each year the same kind of fertilizer is applied to the individual plots on which five trees are growing and the results judged by comparing the yield and the size of the fruit and the tree growth with that of trees growing on unfertilized or check plots. The results of the first seven years of harvest have shown that the trees in this experiment would have been practically as well off had not an ounce of fertilizer been applied. During the later years the continuous applications of acid phosphate alone and of stable manure have continued to produce no noticeable increase of yield; potash and acid phosphate together have produced a slight increase in yield, but this has not been increased further by also adding nitrates. On the whole the differences in fertilized over unfertilized plots have been so slight that the use of any one kind of fertilizer or combination of them cannot be recommended. The use of fertilizers is hence found to be of doubtful profit for commercial orchards, at least during the first twenty years of the life of a cultivated orchard grown on a clay soil that is naturally rich in phosphorus and potash.

Better Concrete

IN a series of tests at the University of Texas, specimens of concrete prepared with an excess of water showed a considerable reduction in strength, as compared with mixes in which only enough water was used to secure a concrete of workable consistency. Now in practical operation it is absolutely necessary to use enough excess water, over the minimum requirements of mixing, to make the concrete sufficiently fluid to be handled in wheelbarrows, carriages, etc., and so that it will flow readily into the form, and between and around the reinforcing steel. This means that an excess of water must be employed to place the concrete correctly and economically, and that this excess water materially reduces the strength of the concrete. The question arises whether something cannot be done to counteract this unfortunate effect.

To answer this Mr. G. A. Parkinson of the University staff made efforts to remove the excess water after the deposition of the concrete in the forms. If a pointed iron rod is forced into the concrete while it is still soft, he found that the excess water and likewise the entrapped air is permitted to escape upward, compacting the aggregate and increasing the density by some four per cent. This method of treatment has been called rodding; emphasis is placed upon the fact that while quite similar to spading, it differs materially from tamping.

Some of the results of the rodding tests are of great interest. The same procedure was gone through with fifty-four cylinders, six by twelve inches each, divided into three groups of eighteen each. In each group one cylinder was not rodded at all, one was rodded once, one twice, and so on until one was rodded seventeen times. In one of the three groups ten-minute intervals were allowed between successive roddings of a given cylinder; in the second group these intervals were increased to twenty minutes; and in the third to thirty minutes. In every case the first rodding was applied soon after the molds were filled, without waiting for the full interval assigned the series to elapse.

A single rodding, it may be necessary to state, does not mean a single thrust of one rod. It means the pushing of a rod into the concrete, to the full depth of the latter, once for every three square inches of surface area—or in the case of the test cylinders, ten times.

It is interesting to note that the maximum strength of rodded cylinders is about 130 per cent of that of the unrodded specimens. All three series acquired their maximum strength in about two or two and a half hours, though of course with different numbers of roddings. That is to say, for the 30-minute interval it required five roddings; for the 20-minute interval seven roddings; and for the 10-minute interval fourteen roddings, to attain maximum strength. It seems probable that the length of time and the number of roddings necessary vary with the temperature and with the percentage of water present in the first place.

The rodding was also tried with three groups of cylinders in which the mix contained, respectively, four, six and eight sacks of cement per cubic yard, while in the individual cylinders of each group the water content was varied. Comparing the results with the standard formulæ for the strength of plain concrete, formulated by Professor Abrams of the Lewis Institute, it appears that the effect of rodding is more beneficial with lean than with rich mixes, and that as might be expected it is more beneficial with wet than with dry mixes. Thus, the average strength of 8-sack concrete was increased only 45 per cent (approximately by rodding), and that of 6-sack mixes some 60 per cent; but with the very lean 4-sack mix the improvement was around 220 per cent.—*F. E. Giesecke.*

Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to Correspondents are printed from time to time and will be mailed on request. Please write your queries: do not telephone them, please.

(14326) H. H. asks: A person born on Easter Sunday, April 21, 1889, when will his birthday fall on Easter Sunday again? A. The next time when Easter Sunday will fall on April 21st is in 1935, then in 1946, and in 1957. These are all the years of this century when Easter will occur on April 21st.

(14327) W. J. M. asks: I have had a problem bothering me for some time on which I should like to hear the opinion of anyone who thinks he has a solution. It is known that the sun has its heat replenished to a considerable degree by impacts of numerous meteorites upon it. As this process goes on, the sun is constantly growing larger, not appreciably but undeniably, by the addition of the masses of these falling bodies. This, which is true of the sun, is just as true of all other heavenly bodies. Furthermore, as these bodies grow larger by these additions, their attraction becomes greater and not only do the meteorites fall at increased speeds but more of them fall. It is apparent the universe as we know it could not exist for long in this state.

With what I have just said in mind, I see only two ways of accounting for the existence of the universe as we know it. Either the universe has been "condensing" throughout infinity from an infinitely fine gas to its present state with unit matter as its final goal or there is some agent at work to keep this from happening. If the first is true we have added another remarkable coincident to the already great number that we accept to explain the existence of the human race. If the second is true, the force which balances our universe must be of a very interesting nature, scientifically. The probabilities are very much against the first theory.

Can it be possible that a body can become so large that its own weight will cause the atoms at its center to be broken up into some basic material, such as that which we call ether, which will then filter out to recondense in the form of matter when conditions become such as to make it possible? A. Astronomers are agreed that the weight of meteors added to the earth or the sun in any moderate period of time such as a century is very small, too small to appreciably affect its mass. If there was such an effect it would cause a decrease in the size of the orbit of a planet and cause it to approach the sun. If as some think there may have been a more rapid accretion of meteors in remote past ages than this effect may have been experienced to a degree. You will find this topic treated at some length in Moulton's Introduction to Astronomy, which we will send you for $3.10.

(14328) K. C. A. asks: Please let me know method of filling a barometer tube so as to get complete vacuum and proper height of mercury column. A. Filling a barometer tube properly so as to include no air is not easy. The mercury should all be boiled in the tube. Put in not more than four inches and boil it by heating carefully and slowly over a flame. Herein lies the difficulty. If you do not heat quite a section of the tube, at least six inches it will break. Or if you heat the tube unequally it will suddenly brea':. Probably the experts heat the tube in a sand bath. When one section has been boiled to expel the air and has cooled another similar length may be filled and boiled as before. You will probably break several tubes in getting experience, but if you succeed you will have a barometer to be proud of. Usually amateurs take a wire with a small swab of absorbent cotton twisted in at the end and run this swab to the bottom of the tube. Then fill the tube with mecury and draw the swab slowly out. The cotton will bring with it nearly or perhaps quite all of the air in the mercury and on the glass in the tube. You should get much better than 29 inches at sea level with a barometer filled with the swab of cotton employed to draw out the air. You can get the correct reading of the barometer at the Weather Station in your place.

(14329) W. M. D. asks: Please tell me what the message from Mars was and where received, and when. I would like all information that I could get on Mars. A. There were certain sounds heard on the wireless apparatus which could not be made out. They were not words nor anything like our language. These disturbing noises were not explained by anyone. Some one suggested that they were signals sent from Mars. There is nothing more than that in this matter. It is very unlikely that any signals could be sent from Mars to the earth. We cannot now send half way around the earth, 12,000 miles. How could we send 35,000,000 miles to Mars? Nor have we any reason to think that the inhabitants of Mars, if there are any, would have the same language as our English speech. We could not talk with an inhabitant of Central Africa, how then with a Martian? There is little or nothing in the notion that signals have reached the earth from Mars.

(14330) F. H. M. asks: "What would be approximately the number of cubic feet air inhaled by a person during 8 hours' sleep? About what per cent of oxygen is used from the air by the body in breathing? Does air exhaled have greater specific gravity than air inhaled? Would such air have a tendency to settle to the floor of the room?" A. The average capacity of the human lungs is one gallon, or 231 cubic inches, but the average inhaled and exhaled at a breath is taken at about 30 cubic inches, thus the air is gradually changed in the lungs and their delicate surfaces are not exposed to the chill of air of a temperature much below their temperature. We may assume 15 breaths per minute as normal, and thus it may be calculated that we inhale about 375 cubic feet of air a day. This is vitiated with 4 per cent of carbon dioxide. This will vitiate 1,500 cubic feet of air to one per cent. This is *bad air*. If 4 parts in 10,000 of carbon dioxide are taken as the least to be permitted a man would require 37,500 feet of air each 24 hours. The oxygen removed from the air in 24 hours is enough to make the carbon dioxide. This may be calculated without difficulty. The exhaled air is hotter than the air of the room and thus at first rises. The carbon dioxide in it does not greatly increase its weight or density. Then, too, the carbon dioxide rapidly diffuses into the air of the room and will in time be found in all parts of the room.

(14331) V. T. S. asks: I had always been under the impression that June 21st was the longest day in the year. But according to the almanac, there are several days around the period of the Summer Solstice on which the elapsed time between sunrise and sunset is virtually the same. To put the question in another way: Is there any one day in June on which the sun at noon attains its highest possible point in the heavens? A. The longest daytime, that is, the time from sunrise to sunset, is about June 21st, but varies a little from year to year. The Summer Solstice is the moment when the sun is exactly at its highest north of the equator. The Vernal Equinox is the moment when the center of the sun is on the equator as it crosses it going north. These times are measured by the astronomer to a hundredth of a second. At the moment of the Summer Solstice the sun is highest in the heavens in any northern place, or, as it is better expressed, farthest north of the equator. The length of daytime as given in an almanac which only gives the minute of sunrise and sunset, neglecting seconds, will not vary for several days at that season, but if you had seconds and hundredths of seconds, there would be but one day when the time from sunrise to sunset was the longest. Now, why does not this occur always on the same day of the year, say, June 21st? That is because the time from January 1st to June 21st is not the same from year to year, while the time from the Vernal Equinox to the Summer Solstice is always the same. Every fourth year we insert an extra day in February which puts June 21st a whole day farther off from January 1st than it was the year previous, and this changes the relation of the almanac time to the astronomical events which do not vary as the calendar does. The answer to your question then is: There is a moment in June when the sun is highest in the heavens but that moment does not always fall on the same day of the calendar, although it is always at the same distance in time from the Vernal Equinox. A good almanac should give you the moment of the Vernal Equinox and of the Summer Solstice. These are respectively the time of the beginning of Spring and Summer.